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Post-PLUARG Evaluation of Great Lakes Water Quality Management Studies and Programs
Volume I

Great Lakes Basin Commission
Ann Arbor, MI

Prepared for

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Volume I

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FOREWORD

The United States Environmental Protection Agency was created because of increasing public and governmental concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimony to the deterioration of our natural environment.

The Great Lakes National Program Office (GLNPO) of the U.S. EPA, was established in Region V, Chicago to provide a specific focus on the water quality concerns of the Great Lakes. GLNPO provides funding and personnel support to the International Joint Commission activities under the U.S.-Canada Great Lakes Water Quality Agreement.

Under the terms of the Agreement a series of studies were funded to examine the relationship between land use and water quality. The studies were conducted by the IJC Pollution from Land Use Activities Reference Group (PLUARG). In order to further build upon the accomplishments of the PLUARG effort, GLNPO contracted with the Great Lakes Basin Commission to prepare this report which describes the work which is continuing to address the problem of pollution from land.

We hope that the information and data contained herein will help planners and managers of pollution control agencies make better decisions for carrying forward their pollution control responsibilities.

Madonna F. McGrath
Director
Great Lakes National Program Office

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This study is to provide an update of activities since PLUARG was presented to the Water Quality Board.

16. ABSTRACT

This report represents the results of recent efforts by the Great Lakes Basin Commission staff to update and integrate the findings and recommendations of the International Joint Commission's Pollution from Land Use Activities.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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POST-PLUARG EVALUATION OF GREAT LAKES WATER QUALITY MANAGEMENT STUDIES AND PROGRAMS

Volume I

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Prepared for the Great Lakes National Program Office, EPA, in partial fulfillment of U.S. Environmental Protection Agency Interagency Agreement No. EPA-79-D-F0857 with the Great Lakes Basin Commission.

This report presents information based in part on the result to date of Great Lakes Water Quality Management studies. Because these studies are ongoing, the findings and conclusions in this report will need to be periodically updated to reflect progress that has been made. This report is intended to promote discussion and further coordination of Great Lake planning effort.

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DISCLAIMER

This study was carried out by the Great Lakes Basin Commission staff in partial fulfillment of an Interagency Agreement with the Great Lakes National Program Office, U.S. Environmental Protection Agency (EPA). The findings, conclusions and recommendations are those of the authors and do not necessarily reflect the views of U.S. EPA or the Great Lakes Basin Commission.

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ATTACHMENTS

1. "Pollution from Land Runoff," feature article published in Environmental Science and Technology on PLUARG

2. "An Update of Water Quality Planning Activities in the Great Lakes Basin - A Review of State and Areawide Agency Five-Year Strategies and Work Programs"

3. "U.S. Air Quality Control Programs - Implications for Improvement of Great Lakes Water Quality"

4. "Methodology for Choosing Among Alternatives to Reduce Pollutant Contributions from Watersheds"

The above four attachments are available from:

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EXECUTIVE SUMMARY

This report presents the results of recent efforts by the Great Lakes Basin Commission staff to update and integrate the findings and recommendations of the International Joint Commission's Pollution from Land Use Activities Reference Group (PLUARG) with other related studies. It is one of a series of U.S. Post-PLUARG activities recommended by the Reference Group to ensure that the initiatives begun under PLUARG are not lost.

The report concentrates on four different areas:

1. update of major water quality studies and resource planning and management programs and projects related to Great Lakes water quality concerns;
2. update of pollutant loadings to the Great Lakes from U.S. sources;
3. results of a survey of current agricultural research into the causes and control of nonpoint source pollution; and
4. reconsideration of PLUARG findings and recommendations in light of new information.

Five appendices and four attachments provide detailed discussions and information to support this report.

The nonpoint source technical findings that have emerged since completion of PLUARG's final report generally continue to reaffirm the PLUARG conclusions. Some local differences in management recommendations have emerged, however. For example, while minimum or no-tillage techniques show great promise for reducing sediment and phosphorus losses from northwestern Ohio, these techniques do not appear as applicable (or as publicly acceptable) in southwestern Wisconsin.

Some PLUARG recommendations for information needs still require attention. Additional data are needed on atmospheric inputs of toxic substances, since evidence continues to mount that atmospheric fallout is perhaps the major source of toxic chemicals in the lakes. Additionally, quantitative comparisons of the incremental water quality benefits and costs associated with alternative control measures are still required.

A number of national and regional financial assistance programs are contributing to the development and implementation of nonpoint source remedial measures throughout the basin. It will be important to integrate results from these programs into an overall Great Lakes management strategy. An approach such as the Wisconsin Nonpoint Source Pollution Abatement Program, which provides state funding for developing and implementing control programs for priority watersheds, merits consideration for use elsewhere in the basin.

The potential exists for integration of major resource planning and management programs in the basin. Programs administered under the Clean Air and Clean Water Acts are an obvious starting point. A closer correspondence also needs to be developed between state water quality standards and the objectives established in the Great Lakes Water Quality Agreement.

The phosphorus management strategy recently suggested by the Great Lakes Basin Commission, which calls for implementation (at present) of the 1.0 mg/L phosphorus effluent limitation for sewage treatment plants discharging 1 million gallons per day or greater, still appears to be desirable. The International Joint Commission's Phosphorus Management Strategies Task Force, which is in the process of determining whether or not a 0.5 mg/L P limit should be set, may recommend that municipal plants be encouraged to control phosphorus at an intermediate level (between 0.5 and 1.0 mg/L). This reduction would be achieved through more efficient management of phosphorus removal processes. Thus, it would involve little additional cost. Such a recommendation, if made, is consistent with the Basin Commission's suggested strategy.

Because of recent changes in federal program direction, Areawide Water Quality Management (208) programs will likely emphasize projects addressing nonpoint source pollution. It appears that those programs which can be developed at low cost (i.e., voluntary programs) are still the most desirable in terms of cost-effectiveness. Toward this end, transfer of the information and technology developed by PLUARG and under other studies (both completed and ongoing) will assume an even higher priority.

While the five-year strategies of state and 208 planning agencies in the Great Lakes basin generally do not specifically address Great Lakes concerns, the results of their work will likely have a major impact on the Great Lakes.

CONCLUSIONS

NONPOINT SOURCE POLLUTION MANAGEMENT

1. Results of the Pollution from Land Use Activities Reference Group (PLUARG) technical studies recently completed tend to reinforce the PLUARG recommendations published in 1978.

2. Nonpoint pollution management recommendations resulting from local studies cannot always be applied to other areas. This is illustrated by the differences in management recommendations, based on local physical and social factors, that are evident when comparing the Washington County, Wisconsin, (108) Project with the partially completed Honey Creek, Ohio, Project. For example, results from the Washington County (108) Project indicate that the water quality benefits attributable to grass waterways and subsurface drainage systems in relatively flat watersheds were minimal. In contrast, studies in the relatively flat Maumee basin in northwestern Ohio indicated that such measures had a definite beneficial water quality impact.

3. Additional information is needed to relate the costs of various agricultural management practices to the incremental water quality benefits obtained.

4. The Agricultural Conservation Program, in conjunction with technical assistance from the Soil Conservation Service, Forest Service, and agricultural extension services, appears to be an effective means of implementing many PLUARG recommendations at the local level, especially in the area of sediment control from agricultural land use.

5. Objectives and activities proposed for the new Soil and Water Resources Conservation Program concerning soil resources, water quality, and fish and wildlife habitat (specifically, wetlands) are consistent with recommendations made by PLUARG. Activities already underway in the basin, such as the Wisconsin Nonpoint Source Water Pollution Abatement Program, may serve as useful prototypes for future nationwide efforts under this program.

6. The Nationwide Urban Runoff Program is expected to provide needed information on the benefits and effectiveness of urban controls so that the necessity for controls beyond those recommended by PLUARG can be ascertained.

7. Results from the Washington County (108) Project indicate that local sediment control regulations could put resident farmers and developers at a competitive disadvantage with those of other areas of the state. Some type of minimum statewide standard for regulating erosion may, therefore, be necessary.

8. Minimum or no-till methods, strongly advocated in the U.S. portion of the Lake Erie basin, may not be applicable in all parts of the Great Lakes basin. In contrast with preliminary findings from the Honey Creek Project under the Lake Erie Wastewater Management Study (LEWMS), results of the Washington County (108) Project indicated that grain yields from no-till sites were significantly lower than from sites prepared by other plow methods.

9. PLUARG's conclusions regarding the significance of the sediment contribution from developing lands are substantiated by recent modeling efforts under the Menomonee Pilot Watershed Study and results from the Washington County (108) Project.

10. PLUARG's conclusion that streambank erosion does not appear to be a significant source of sediment or phosphorus to the Great Lakes is substantiated by the initial results of the Cuyahoga River Restoration Study which indicate that streambank erosion along the Cuyahoga is a much less significant source of sediment than was previously thought.

11. Recent work involving PLUARG's overview modeling process emphasizes the importance of evaluating remedial programs on a comprehensive basis. For example, measures to control phosphorus associated with urban runoff may not be cost-effective strictly in terms of reducing phosphorus loading. However, urban runoff controls may have other benefits, such as reducing heavy metal loads, which should be considered in a cost-effectiveness analysis.

POINT SOURCE POLLUTION MANAGEMENT

1. Based on recent information, it appears that the August, 1979, resolution of the Great Lakes Basin Commission is still appropriate. The resolution calls for a phosphorus management strategy that, at present, emphasizes implementation of the 1.0 mg/L phosphorus effluent limitation for sewage treatment plants discharging 1 million gallons per day or greater.

2. The International Joint Commission's Phosphorus Management Strategies Task Force is in the process of determining whether or not a 0.5 mg/L P limit should be established. They may recommend that municipal plants be encouraged to control phosphorus at an intermediate level, between 0.5 and 1.0 mg/L, through more efficient management of phosphorus removal processes. Such a recommendation, if made, would be consistent with the Basin Commission's resolution.

AREAWIDE WATER QUALITY PLANNING

1. Areawide Water Quality Management Plans (208 plans) have been prepared and certified for almost every area of the basin. A sizeable number have received EPA approval as well. Because they identify management agencies responsible for water quality improvements at the local level, these plans form a comprehensive basis on which to build a management program.

2. Generally, the five-year strategies and work programs developed by the Great Lakes states and areawide planning agencies (208 agencies) focus on (1) point and nonpoint sources of pollution, (2) residuals and sludge management, (3) toxics, (4) updating land use and population projections, and (5) implementation of water quality studies. Few studies are specifically designed to address Great Lakes issues.

3. Due to recent changes in federal program direction for Section 208 Water Quality Management, highest funding priority in the future will be assigned to programs addressing nonpoint source pollution.

UPDATE ON POLLUTANT LOADINGS TO THE LAKES

1. It appears that the loads developed by PLUARG (given an updated estimate of the Lake Erie load) will be adopted by the Phosphorus Management Strategies Task Force as the best estimates of 1976 loadings to the lakes.

2. Evidence to date still confirms PLUARG's finding that a substantial portion of the phosphorus in tributary loadings is not biologically available. This fact must be taken into account as future phosphorus management strategies are developed.

3. 1975 and 1976 were years of very high flows (relative to the long-term historical flow) for all of the lakes except Superior. 1977 was a very low flow year for all of the lakes. In 1978, flows returned to average or above average conditions. Generally, associated tributary loadings of total phosphorus, ortho phosphorus, suspended solids, and chloride were greater during water year 1978 than 1977. In fact, tributary loads for 1977 appear to be the lowest over the period 1975 through 1978. (A more detailed assessment of 1977 and 1978 tributary loads is planned for a future report).

EFFECT OF U.S. AIR QUALITY CONTROL PROGRAMS ON GREAT LAKES WATER QUALITY

1. Air and water pollution control programs in the United States have developed independently, resulting in separation of enforcement, monitoring and administrative responsibilities, especially at the state and local levels. As a result, it may be difficult to reconcile the two in areas of common concern (for example, toxic substances entering the Great Lakes via air deposition).

2. Although mechanisms for air and water quality planning coordination are available, they have been little used. The major involvement of local agencies, some of which are preparing areawide (208) water quality plans, has been with respect to transportation-related problems. Coordination at the federal level has been carried out by the Intermodal Planning Groups in each federal region.

3. The Great Lakes states are in various stages of progress in preparing State Implementation Plans for the criteria air pollutants. There are no indications at this time that any of the states will not fulfill their regulatory obligations in this area.

4. It does not appear that the National Emissions Standards for Hazardous Air Pollutants (NESHAPS) program will have a significant effect on reducing atmospheric inputs of key hazardous substances to the Great Lakes, since air pollutants regulated under the NESHAPS program do not appear to cause serious problems in the lakes. At this time, all basin states do not have authority to enforce current NESHAPS regulations and several do not have authorization to adopt new standards as they are promulgated by EPA.

5. It does not appear that the release of PCB, an important airborne Great Lakes contaminant, can be effectively controlled through existing and proposed air quality regulations. More information is needed on the relative contribution of PCB from different sources.

RECOMMENDATIONS

The following are offered as recommendations, in addition to the many implicit recommendations included in the "Conclusions".

1. To most effectively reduce nonpoint source pollution, more attention should be directed toward implementing remedial measures. Toward this end, improvements should continue to be made in the areas of technology and information transfer.

2. Nonpoint source control programs which advocate implementation of voluntary measures should be instituted immediately.

3. Measures should be taken to determine how state, regional, and local governments can keep the water quality management continuing planning process active, as federal "208" monies are directed elsewhere.

4. Complete implementation of the 1.0 mg/L phosphorus limitation at municipal treatment plants of 1 million gallons per day or greater should continue to be encouraged. The effect of this control measure should be carefully evaluated.

5. A workshop should be planned for the near future to evaluate the progress that has been made toward understanding nonpoint source pollution since the PLUARG report was completed, and to evaluate the progress that has been made in implementing nonpoint source controls. Invitees should include key PLUARG investigators as well as representatives from other key nonpoint source studies, such as the "108" studies, the Lake Erie Wastewater Management Study, the Nationwide Urban Runoff Program, etc.

6. The "overview modeling" process should be adapted for use by land managers both within and outside of the Great Lakes basin to aid them in determining the most cost-effective mix of management techniques for a watershed. This could be accomplished by preparation of a handbook for the land manager's use.

7. Information from the large number of ongoing agricultural research projects addressing nonpoint pollution in the basin should be used to update PLUARG findings and, if appropriate, to modify strategies for managing nonpoint inputs to the Great Lakes.

8. To help maximize utilization of "208" planning information in other planning and management activities, a bibliography of Great Lakes area water quality management planning reports should be completed. Such a bibliography has already been partially prepared by the Great Lakes Basin Commission staff.

9. Results from the several regional studies and demonstration projects which will begin or be completed over the next few years (e.g., the Saginaw Bay Special Project and the Saline Valley Project) should be utilized in the evolution and maintenance of a Great Lakes management strategy. Additionally, as mentioned in the first Post-PLUARG report, the feasibility of the Wisconsin Nonpoint Source Water Pollution Abatement Program approach to developing and implementing nonpoint source control programs for priority watersheds should be evaluated for use elsewhere in the basin.

10. Results from the U.S. Post-PLUARG tributary monitoring programs, such as those in Ohio and Wisconsin, should be integrated into the overall PLUARG data base.

11. Better coordination is needed between air and water quality planning and management programs. Inclusion of air pollution control programs in state-EPA agreements and five-year strategies would be an important first step in achieving this. The potential role of local water quality planning agencies in air pollution control programs should also be explored.

12. Research and planning activities aimed at clarifying the sources and impacts of airborne contaminants (particularly PCBs) to the Great Lakes should be expanded. Of special concern are toxic substances not currently included or proposed for NESHAPS control. Evidence is mounting that atmospheric fallout is the major source of toxic substances to the Great Lakes.

13. Efforts to reduce atmospheric emissions of PCBs should place additional emphasis on landfill disposal sites. NESHAPS-type controls should be implemented where feasible.

CHAPTER 1

INTRODUCTION

The multimillion dollar study conducted by the International Joint Commission's Pollution from Land Use Activities Reference Group (PLUARG) was initiated as a result of the 1972 United States-Canadian Agreement on Great Lakes Water Quality. It was one of the most extensive studies of nonpoint sources of pollution ever conducted (see Attachment 1). PLUARG's final report was presented to the U.S.-Canadian International Joint Commission (IJC) in July of 1978. The IJC has completed their review of PLUARG's findings and recommendations, but their comments are not yet available.

Under an Interagency Agreement with the U.S. Environmental Protection Agency (EPA), the Great Lakes Basin Commission (GLBC), in cooperation with the Great Lakes National Program Office (GLNPO) of EPA, has undertaken a number of activities to ensure that the findings and recommendations of PLUARG are considered and incorporated into ongoing water quality planning and management programs in the basin. The first Post-PLUARG report, entitled "Post-PLUARG Evaluation of Great Lakes Water Quality Management Studies," was completed in July of 1979 (Skimin et al., 1979). This report updates a number of work efforts initiated under the previous Agreement and provides information on recent activities, both completed and ongoing.

Chapter 2 of this report provides updated information on a number of significant studies and programs of relevance to Great Lakes water quality problems. Results of PLUARG pilot watershed studies that have recently become available are described. Recent developments from the U.S. Army Corps of Engineers' Lake Erie Wastewater Management Study (LEWMS) are discussed. Recent efforts under the Wisconsin Nonpoint Source Water Pollution Abatement Program (Wisconsin Fund) and the Corps of Engineers' Cuyahoga River Restoration Study are presented.

A number of nationwide programs are currently addressing the problem of nonpoint source pollution either directly or indirectly. Chapter 2 includes reviews of projects being conducted in the basin under the auspices of the Rural Clean Water Program, the Agricultural Conservation Program and the Nationwide Urban Runoff Program. A draft appraisal and program plan for soil and water conservation under the Soil and Water Resources Conservation Act (RCA) of 1977 has recently been released by the U.S. Department of Agriculture. Objectives and program activities outlined in this report are reviewed in light of PLUARG's recommendations.

Chapter 2 also presents updated information on the status of Section 208 water quality management planning activities underway in the basin. The function of the five-year strategies in the planning process is discussed. The bibliography of 208 documents being prepared by the Basin Commission is described. This work effort is expected to continue over the next few months.

The potential for improvement of Great Lakes water quality resulting from implementation of U.S. air quality control programs, is discussed in this section. Although the final report of the Phosphorus Management Strategies Task Force has not yet been completed, several preliminary subreports have been developed. Major conclusions reached in these reports have been summarized.

Chapter 3 describes current efforts to assess pollutant loadings to the Great Lakes from U.S. sources. The status of tributary monitoring programs recommended by PLUARG is discussed. Recent work efforts, under the Great Lakes Environmental Planning Study (GLEPS), utilizing the overview modeling process are reviewed and summarized. The modeling process's potential for use as a planning tool outside of the Great Lakes basin is discussed. River mouth loadings calculated by GLBC staff for water years 1977 and 1978 are also presented.

The results of a survey of current research efforts into the causes and control of nonpoint source pollution are presented in Chapter 4. The survey focused on agricultural research activities being conducted at universities and research stations, primarily in the Great Lakes basin.

Findings of projects particularly relevant to Post-PLUARG interests are discussed and future research needs highlighted.

Finally, Chapter 5 attempts to draw everything together. Study findings, conclusions and recommendations which support or contradict those of PLUARG are highlighted.

A great deal of additional information has been included in a series of five Appendices. Also, because portions of this final report were supplied to the Great Lakes National Program Office as they were completed, it was judged to be more expeditious to include these self-contained sub-reports as a series of four Attachments.

CHAPTER 2

UPDATE ON WATER QUALITY STUDIES AND RESOURCE PLANNING AND MANAGEMENT PROGRAMS

The first Post-PLUARG report (Skimin et al., 1979) discussed a number of water quality studies and programs in the process of developing detailed information on the causes and control of nonpoint source pollution. These included the PLUARG pilot watershed studies, the Lake Erie Wastewater Management Study, the 108(a) Demonstration Projects and the Wisconsin Nonpoint Source Water Pollution Abatement Program (Wisconsin Fund) on a regional level; and the Nationwide Urban Runoff Program and Rural Clean Water Program on a national level. This chapter updates information contained in the previous Post-PLUARG report and describes a number of additional studies and programs which are addressing problems relevant to Post-PLUARG interests. Additionally, initial information available from the work of the Phosphorus Management Strategy Task Force is reviewed and summarized.

PILOT WATERSHED STUDIES

Task C of the Pollution from Land Use Activities Reference Group (PLUARG) was to determine the locations and characteristics of diffuse sources of pollutants entering the Great Lakes basin from a range of land use activities. The relative significance of the pollutants and processes involved in their transmission to the lakes were to be identified. Pilot watersheds representative of physiographic features and land uses present in the basin were selected for intensive investigation. Summaries of these eight studies were completed at the time PLUARG reported to the International Joint Commission (IJC). Since then, a number of detailed reports have been published.

Menomonee River Pilot Watershed Study

The Menomonee River watershed in Wisconsin was selected to examine the diffuse source contributions of urban-residential land uses. A summary report was published in May, 1978. Since then, a number of draft reports of detailed studies have become available. The draft reports on groundwater hydrology and atmospheric chemistry were reviewed in "Post-PLUARG Evaluation of Great Lakes Water Quality Management Studies" (Skimin et al., 1979). Two additional reports have been received since then.

A detailed study was put out in October, 1979, on the effects of inputs from the Menomonee, Milwaukee and Kinnickinnic Rivers on Lake Michigan water quality (PLUARG, 1979a). The study focused on the area around the Milwaukee Harbor. The effect of the Menomonee River on lake water quality could not be isolated from that of the Milwaukee and Kinnickinnic rivers. However, estimates indicated that 50 percent of the annual river loadings reaching the harbor were contributed by the Menomonee.

Water quality surveys were conducted in the inner and outer harbors and inshore and offshore zones during periods of high and low flow in the rivers. Surveys indicated that concentrations of nutrients, suspended solids and metals decreased with increasing distance from the confluence of the rivers. Wisconsin researchers found that runoff events had an immediate effect on harbor water quality. Water quality of the inshore zone was usually not degraded during high flow events.

Mechanisms controlling the transport of pollutants between regions were studied. It was determined that net transport of event and baseflow water to the inshore zone was primarily dependent on harbor current patterns, and that a significant portion of the annual loadings of pollutants from the Jones Island sewage treatment plant and the rivers were retained in the harbor due to deposition. Percentages of the total annual loadings entering the inshore zone were estimated as 45 percent for suspended solids, 61 percent for total phosphorus, and 35 percent for soluble phosphorus. About 70 percent of the suspended solids discharged from the Menomonee River were retained annually in the inner harbor.

A two-part draft report on studies utilizing the LANDRUN model was made available in November, 1979 (PLUARG, 1979b). The model was used to simulate runoff and sediment loadings from 43 subwatersheds of diverse land uses and physiographic features in the Menomonee River watershed. Nine subwatersheds, consisting of 16 percent of the total area, were identified as critical source areas. Developing lands were identified as the primary contributors (50-85 percent) of sediments. Thus, management of these sources can be particularly cost-effective. This confirms PLUARG's conclusion regarding the importance of controlling erosion from urban construction sites.

A Model Enhanced Unit Loading method (MEUL) utilizing LANDRUN was developed to simulate pollutant loadings from urban and non-urban land uses. Simulated loadings were evaluated as if the land uses were located on four hydrologically different soils, representative of standard hydrologic categories. Pollutant loadings varied by several orders of magnitude among land uses.

Sensitivity analyses tested various parameters as to their effect on loadings. The most significant facts were found to be the extent of imperviousness of urban areas, fraction of impervious areas directly connected to surface runoff, interception and depression storage, average duration of the dry period before a rain, curb height for urban areas, and soil type, slope and vegetative cover for pervious urban and non-urban areas. Again, this further supports the findings of PLUARG.

The applicability of the unit loading data obtained by the MEUL method was tested on a number of subwatersheds. Simulated and measured values for sediment and phosphate-P were of the same order of magnitude. The MEUL model provides a more detailed approach for estimated nonpoint pollutant loads than the "overview model" approach (Johnson et al., 1978) used in PLUARG. However, the data requirements are much more restrictive. As the name implies, overview modeling is designed to address a large area (i.e., the entire Great Lakes basin), while MEUL is most appropriately applied to smaller areas. Because of the urban focus of the Menomonee study, MEUL is likely to be especially useful in future analyses of urban areas.

Maumee River Pilot Watershed Study

The Maumee River Basin is primarily agricultural. Studies by the U.S. Army Corps of Engineers and the Great Lakes Basin Commission have indicated that nonpoint sources account for about 75 percent of the phosphorus and nitrogen entering Lake Erie from this watershed. It was thus decided to emphasize soil and nutrient losses from small agricultural watersheds in this study and to conduct special investigations on sediment transport. The project focused on the Ohio portion of the Maumee to supplement work being conducted in the Black Creek, Indiana, 108(a) Demonstration Project. Black Creek is tributary to the Maumee.

As reported in Skimin et al. (1979), a summary report of the major findings from the Maumee Pilot Watershed Study was published in April of 1978. A two-volume detailed report describing the results was published in March of last year (Logan and Stiefel, 1979; Logan, 1979). The following is a summary of the highlights of these recent reports.

Study Objectives. The specific objectives of the study were:

1. "To determine the effects of land-use practices on the loss of sediment and associated chemicals from representative small agricultural watersheds in the basin and to compare these data with downstream reference samples.

2. To study and determine the physical, chemical, and mineralogical properties of major soils in the basin and relate these data to their susceptibility to erosion and fluvial transport.

3. To determine the physical, chemical, and mineralogical properties of suspended sediments and bottom sediments in order to identify fluvial transport mechanisms and to evaluate equilibrium stabilities of minerals in suspended and bottom sediments.

4. To determine phosphate sorption-desorption and precipitation interactions with sediment characteristics and concentration levels.

5. To determine heavy metals leaving small agricultural watersheds as contrasted to downstream reference sources." (Logan, 1979)

Study Approach. The basic approach of the study was to measure sediment and nutrient losses from small agricultural watersheds and plots on major soils in the Maumee River basin and compare these losses with those from larger areas in the watershed. The study investigated the differences in pollutant generation on several of the major soils of the Maumee basin and determined the effects of seasonal changes and soil characteristics on sediment and nutrient generation. Pollutant transport by tile drainage was also studied because of the extensive use of this practice in the basin.

Five small sites were chosen in Defiance County to monitor soil and nutrient losses under the prevailing crop management practices. Each site chosen was dominated by one of the four most important soil series in the basin. Surface runoff was monitored from May 1975 to May 1977, using a continuous flow monitoring system. All sites were fall-plowed and planted in soybeans. Any differences in sediment and nutrient losses were therefore a function of differences in soil type.

Results. Monitoring results obtained during 1975 to 1977 indicated that there were significant differences in sediment and nutrient losses among different soil types in the Maumee basin. Greatest sediment losses occurred on the poorly drained, high clay, lake plain soils. Lowest losses were reported on soils with good internal drainage characteristics which were tile drained.

Total phosphorus content of soils was determined to be high (approximately 700 ug P/g sediment) as a result of their high clay content and phosphorus enrichment in the clay fraction of mineral soils. Soils and bottom sediments demonstrated a large capacity to adsorb phosphorus, while suspended sediments were high in phosphorus that could be desorbed into solution.

Stream sediments, therefore, had the capacity to reduce high point source contributions of soluble phosphorus and were capable of releasing large amounts of phosphorus to aquatic vegetation.

Heavy metals were measured in soils, sediments, and waters. Levels of trace metals in the Maumee River were low and reflected background levels in the soil and normal metal contributions from groundwater. Although scattered point sources of heavy metals contributed little to the total load, their effect on near-downstream water quality could be severe. A pesticide scan of agricultural soils and stream-bottom sediments revealed only traces of persistent chlorinated hydrocarbons such as DDT and dieldrin.

Recommendations. The authors of the study made several recommendations concerning the Maumee basin in particular and the Great Lakes system as a whole:

1. Point source phosphorus reductions must be continued, with emphasis on lakeshore dischargers (e.g., Toledo) and those located on main stem tributaries. Point source phosphorus reductions are vital in the Toledo area if nearshore water quality problems are to be improved in Lake Erie.

2. Fertilizer and manure management should more accurately reflect crop requirements and soil-test levels. Soil test results should be used to monitor available nutrient levels in regions of intensive cultivation. Educational programs should stress the importance of following soil test recommendations, as plant-available phosphorus levels in the Maumee soils are generally adequate for maximum crop production. Fertilizer mismanagement only results in the enrichment of suspended sediment.

3. Programs to reduce soil loss resulting from intensive agriculture activity should be accelerated, with emphasis on medium- and fine-textured soils on sloping land. Depending on the particular soil/slope combination, various agricultural conservation practices are advocated to reduce transport of the generally fine-grained Maumee soils. These include no-till plowing, grassed waterways and buffer strips, subsurface tile drainage, and establishment of residue cover.

4. Cropland erosion control should be geared to the months of January through April when snowmelt and runoff result in maximum erosion and transport of sediment. Conservation practices which maximize residue cover during this period are likely to be more effective than measures to reduce sediment transport.

5. A tributary monitoring program should be developed to periodically scan water and sediment for toxic chemicals.

LAKE ERIE WASTEWATER MANAGEMENT STUDY

The results of Phases I and II of the Lake Erie Wastewater Management Study (LEWMS) were discussed in "Post-PLUARG Evaluation of Great Lakes Water Quality Management Studies" (Skimin *et al.*, 1979). Phase III of LEWMS will run through October, 1981, when the final report, presenting a management plan for the U.S. portion of the Lake Erie watershed, will be published. In Phase III, methods are being developed to implement management practices and to measure progress in reducing pollutant loading to the lake.

Honey Creek Watershed Management Project

The Honey Creek Watershed Management Project is one of the major programs of Phase III of LEWMS. The end result will be a work plan for management of the entire watershed with emphasis on problem identification and development of site specific management practices.

As one of the components of the study, mulch-till and no-till demonstration plots were established on several farms representing a range of soils and management systems. Crop productivity, time savings, costs, and effect on water quality are all being documented. In October of 1979, a two-day seminar/tour was held in Bucyrus, Ohio, in the Honey Creek watershed. Initial results were presented from several of the demonstration farms in the area. A summary of the major findings is included in Appendix A, "Lake Erie Wastewater Management Study: Honey Creek Watershed Management Project." Generally, time and money-saving benefits were realized by those farmers utilizing the no-till practice. Improvements in water quality attributable to implementation of no-till farming are still being monitored.

Information from productivity tests has become available since the seminar/tour was conducted. The results appear very promising. The 1979 corn harvest ranged from 90 to 185 bushels per acre, with an average of 135 for no-till. Yields from conventional farming normally range from 104 to 107 bushels per acre. The soybean harvest ranged from 25 to 49 bushels per acre, with an average of 40 bushels per acre reported for no-till. Normal yields ordinarily range from 33 to 35 bushels per acre (Crumrine and Wurm, 1980).

Five Additional Basin Studies

Because there are many critical land forms, land uses, and soil types not found in the Honey Creek watershed, five additional watersheds have been selected to provide complete representation of conditions existing in the Lake Erie basin. The five watersheds are:

Bean Creek - Michigan
South Branch of the Cattaraugus - New York
West Branch of the Rocky River - Ohio
Sandusky River Basin - Ohio
Ottawa River - Ohio

Baseline water quality and quantity data are currently being collected. This data will be utilized to calibrate and verify a diffuse source model for each watershed. The Land Resource Information System (LRIS), developed for the Lake Erie drainage basin, is presently being used to formulate a data base for each watershed. Present basin conditions, potential gross erosion sources, and opportunities for implementing best management practices (BMPs) will be summarized in map and tabular form using LRIS.

In the future, model management programs will be developed for each basin. Final reports will detail opportunities for improving water quality by altering farm management practices and applying soil conservation practices. Information will be sufficient for land managers to begin implementation of select BMPs, perhaps under the auspices of the Rural Clean Water Program.

SECTION 108(a) DEMONSTRATION PROJECTS

Section 108(a) of the 1972 Amendments to the Federal Water Pollution Control Act (P.L. 97-500) authorizes the administrator of EPA "to enter into agreements...to carry out one or more projects to demonstrate new methods and techniques and to develop preliminary plans for the elimination or control of pollution, within all or any part of the watersheds of the Great Lakes." The first Post-PLUARG report (Skimin et al., 1979) discussed the major findings and recommendations contained in the final reports of three of the 108(a) demonstration projects which have studied nonpoint source pollution problems and solutions: Black Creek, Western Lake Superior Red Clay Erosion, and Rochester, New York. Since then, the final technical report of the Washington County Project has become available (Madison et al., 1980). A summary of its major findings, conclusions and recommendations is presented in Appendix B.

CUYAHOGA RIVER RESTORATION STUDY

The Cuyahoga River Restoration Study was initiated by the Flood Control Act of 1968 (Section 219) which authorized a survey of the river "in the interest of flood control, pollution abatement, low-flow regulation, and other allied water purposes." The scope of the study was broadened under Section 108 of the 1970 Flood Control Act where "water quality, environmental quality, recreation, fish and wildlife" values were recognized in addition to flood control.

The First Interim Report was completed in September of 1971 (U.S. Army Corps of Engineers, 1971). It identified a long-range plan of action and presented an early-action program to be implemented in 1973. The plan recommended recreational and aesthetic improvements, debris removal, and flood control along the river.

The Second Interim Report was published in December, 1975. It identified significant flooding problems and developed corrective plans for these areas.

A Revised Plan of Study was issued in July, 1977 (U.S. Army Corps of Engineers, 1977). Study plans for alleviating erosion and sedimentation problems, flood control, and debris removal were included. A detailed investigation of the erosion and sediment problem will be made in the Third Interim Report.

A number of work efforts have already been undertaken. The U.S. Geological Survey (USGS) completed a sediment sampling program in the Cuyahoga basin in FY '78 between Old Portage and Independence. The program verified results of a previous study which indicated that areas within this reach were contributing inordinate amounts of sediment. They determined the total annual sediment yield to be expected from this reach.

The U.S. Soil Conservation Service (SCS), under a two-year Interagency Agreement with the U.S. Army Corps of Engineers, has recently completed their portion of the investigation. Their work effort included a study of streambank and upland erosion on the river and two of its tributaries (Brandywine Creek and Tinkers Creek). SCS has also analyzed the results of a stream cross-section survey (designed to determine the relative amounts of sheet and channel erosion), and the results of the USGS sediment sampling program.

Study results indicate that streambank erosion is a much less significant source of sediment than previously thought. It is now estimated that streambank erosion contributes 52,000 cubic yards of sediment per year to the river (approximately 78,000 tons annually). Of this, roughly 47,000 cubic yards actually reaches the river mouth at the Cleveland Harbor. Dredging performed by the Corps of Engineers and private interests removes 860,000 tons of sediment per year from the harbor. Thus, it is estimated that only 5 percent of this dredged material is attributable to streambank erosion. Future studies have been proposed which will attempt to verify this figure.

The upland erosion study conducted by the SCS divided the reach between Old Portage and Independence into seven subwatersheds for investigation. Results were obtained from only five of these subwatersheds at the conclusion of this portion of the study. Initial results indicate that as much as 41 percent of the harbor sediment is contributed by upland erosion. Corps personnel feel that an additional 20 to 40 percent of the sediment may be derived from point sources such as municipal treatment facilities and steel mills in the area (Aguglia, 1980). This hypothesis will be addressed in future work efforts.

The final product of the Cuyahoga Restoration Study will identify the prime sources of sediment in this reach of the river (between Old Portage and Independence) and recommend areas where erosion control efforts should be instigated. Alternative methods for control will be analyzed and the relative benefits versus cost determined. This is consistent with PLUARG's recommendation that sedimentation of watercourses be controlled by first identifying the problem areas, then implementing cost-effective control measures on a priority basis.

THE WISCONSIN NONPOINT SOURCE WATER POLLUTION ABATEMENT PROGRAM (WISCONSIN FUND)

The Wisconsin Nonpoint Source Water Pollution Abatement Program was established by the Wisconsin legislature in 1978. The purpose of the program is to provide the administrative framework and technical and financial assistance necessary for implementing measures designed to meet the needs identified in water quality management plans.

Cost-sharing monies are available to municipalities, land owners and land operators for installing best management practices. Grants are made on the basis of expected water quality benefits and financial need. Funding is concentrated on selected "priority watersheds" where nonpoint source pollution is a critical problem. Watersheds are selected through a three-step review process involving planning and pollution control personnel, elected officials and members of the public. Only those portions of the watersheds impacting water quality are eligible for funds.

The Wisconsin Nonpoint Source Water Pollution Abatement Program is probably the first example of implementation of nonpoint control measures consistent with the PLUARG recommendations. Such an implementation initiative is related to the direct participation of State of Wisconsin staff in the PLUARG study. The effectiveness of this program should be watched closely, as it will likely serve as a prototype for programs in other states.

Lower Manitowoc River Watershed Study

The Lower Manitowoc River watershed is one of the first five "priority watersheds" selected for inclusion in the 1979 program. A watershed management plan and implementation program were published in October, 1979 (WDNR, 1979). The objective of the program is to reduce the amount of phosphorus entering the nearshore waters of Lake Michigan by 50 percent. This is consistent with PLUARG's recommendation that control programs be implemented to reduce phosphorus loadings to Lake Michigan and that additional reductions of phosphorus be implemented "to reduce local nearshore water quality problems and to prevent future degradation."

Manure carried in runoff from barnyards or frozen or saturated fields was identified as the most serious nonpoint source of phosphorus. Additional sources of concern included: erosion from streambanks and agricultural and construction activities; septic system malfunctions; and urban runoff. Best management practices were identified to control pollution from significant sources. Projects included installation of barnyard runoff control systems and storage systems for manure, as well as initiation of reduced tillage practices, strip-cropping and installation of terraces on cropland.

The Lower Manitowoc River Watershed study will provide a good demonstration project to supplement the 108(a) projects sponsored by U.S. EPA. The focus on manure runoff is important, since this is a key problem in the Wisconsin portion of the Great Lakes basin where dairy farms abound. Manure runoff is also a problem in parts of the Canadian basin as well as in other parts of the U.S. basin.

Anywhere from one to five watersheds will be selected for inclusion in the program in 1980, depending on the 1980-1981 state legislative budget appropriations for the program. The Wisconsin Department of Natural Resources has completed the first phase of selection, identifying the top 20 percent of the state's 330 watersheds with potential water quality problems caused by nonpoint sources. Twenty-four of the 63 eligible priority watersheds are within the Lake Michigan drainage basin.

AGRICULTURAL CONSERVATION PROGRAM (ACP)

The Agricultural Conservation Program is the oldest and largest cost-sharing program for the voluntary implementation of conservation practices on farms. The ACP is administered by the USDA Agricultural Stabilization and Conservation Service (ASCS) in each county of a state. Local control of ACP funds is assured through a county committee composed of agency representatives and three farmers. The committee has complete responsibility for selecting the practices to be cost-shared, the rates of cost-sharing, and the proportion of the county's ACP program to be spent on each practice. Farmers and ranchers who receive ACP funds are responsible for sharing a portion of the costs, for completing the practice according to specifications, for complying with state laws and other regulatory measures, and for maintaining the practice.

Conservation Practices

Environmentally approved practices for each locality are recommended by state and county ACP development groups. These practices are in accordance with PLUARG's recommendations for control programs to reduce sediment loading to the Great Lakes system. Several categories are listed below:

- Prevention of Soil Loss
  - establishment of long-term grasses and legumes through seeding, fertilizer, and liming materials
  - construction of terraces and use of strip or contour farming operations
  - construction of water runoff diversions
  - restoration and establishment of wind breaks
  - encouragement of minimum tillage practices and residue management systems

- Improvement of Water Quality
  - installation of sediment retention and water control structures such as erosion control dams and desilting reservoirs to dispose of excess water
  - establishment of vegetative cover to buffer streambanks
  - construction of sod waterways to prevent erosion from excess water runoff
  - installation of animal waste control facilities below feedlots

- Conservation of Soil and Water Through Forestry
  - planting of trees and shrubs for forestry purposes and erosion control
  - improvement of established stands

- Water Conservation
  - construction of reservoirs and ponds for erosion control, livestock water, and irrigation
  - leveling of land
  - installation of structures to conserve water, prevent erosion, and permit more efficient use of irrigation water (ASCS, 1979).

Any county farmer may apply for cost-sharing funds under the ACP. As of 1979, an individual could receive a maximum of $3,500 in a given year. The government's share of the cost ranges from 30 to 80 percent, depending on the farmer's financial status. Farmers may also request funding as a group, which is useful for installing practices that involve adjoining parcels of land.

Small Farmer Projects

PLUARG recommends that water quality plans be developed for each farm, and that the plan be "commensurate with the farmer's ability to sustain an economically viable operation." Although the cost-sharing provisions of the ACP are generous, many small farmers are still financially excluded from the program's benefits. This concern is addressed by the Small Farmer Projects, funded by reserve funds from the ACP. The incentive for low income farmers to participate is the 90 percent cost share which is paid by the government under this program.

A Small Farmer Project is underway in the Great Lakes basin in the upper peninsula of Michigan -- one of ten pilot projects nationwide. Farmers in Baraga and Houghton Counties face severe soil erosion problems due to the extremely high acidity of the soil which deters the establishment of long-term vegetative cover. A three-year allocation of $265,000 is being spent on 49 farms. Problems being addressed include: correction of high soil acidity by the application of liming materials (an average of 4.5 tons/acre versus a statewide average of 1 ton/acre); erosion control through planting of long-lived legume cover and development of a forest management plan (where applicable); and better water control through improved drainage and ponds.

Special Projects

Special projects are designated by the ACP to solve community-wide agricultural water pollution problems. One of the largest of these projects is located in the Saginaw Bay basin. This area is highly desirable for implementation of an agricultural conservation pilot project due to the intensity of agricultural land use in the area, its relationship to sensitive portions of Saginaw Bay, and because of the generally degraded nature of the inner bay.

Saginaw Bay is highly enriched due to excessive nutrient loadings which result in significant algal growth. Siltation and sedimentation are creating a problem in the nearshore zone and in the tributaries. This is evidenced by the proliferation of rough fish species such as carp and bullhead. Waterfowl habitat has also been degraded due to excessive sedimentation (ECMPDR, 1980).

The ASCS has designated $400,000 for the first year of this project, less $20,000 which will be transferred to the Soil Conservation Service (SCS) for technical assistance to farm owners and operators in the area. The remaining $380,000 will provide cost-share incentives to farmers for utilizing best management practices to reduce sediment and nutrient runoff from hydrologically active areas. It is anticipated that project funding will continue for a total of five years.

This ACP project is designed to provide cost-sharing funds for areas with severe wind or water erosion problems. Soil loss based on the Universal Soil Loss Equation (USLE) is estimated to average 2 tons/acre/year for the flat lakeshore plains. Winds are thought to play a significant role in the delivery of nutrient enriched sediments to the drainage network and, ultimately, to Saginaw Bay. In the water erosion areas, the predominant soil erosion problem is attributable to overland runoff over base soils on moderate slopes. Prior to this project, this area lacked the necessary conservation tillage practices and cover cropping as well as control structures for effectively reducing water-related erosion of these soils.

Three work programs will address the following project objectives:

1. To demonstrate the cost-effectiveness of conservation tillage practices on the clay loam soils of the area; and to encourage more widespread, voluntary utilization of conservation tillage without the availability of cost-share incentives.

2. To demonstrate that an agricultural nonpoint source pollution control strategy can measurably improve the aquatic community of the streams within the project area, and within the nearshore zone of Saginaw Bay (directly impacted by the project area).

3. To demonstrate that the reduction of loadings from agricultural lands under best management practices (especially conservation tillage) will result in measurable improvement of the water quality of Saginaw Bay; and to project the long term impacts on the water quality of Saginaw Bay based upon the implementation of a state agricultural nonpoint source control strategy for critical areas.

Work elements include:

1. Cost-Effectiveness of Conservation versus Conventional Tillage

An effective means of reducing sediment loss due to wind and water transport is through the use of tillage systems which retain surface cover and promote surface roughness. In this manner, wind and water energy capable of eroding the soil is buffered, and a reduction in soil loss as well as associated nutrients occurs. Although conservation tillage is now being utilized within the project area, it appears that farmers will discontinue this practice once federal cost-share funds run out.

In the hopes of encouraging implementation of this practice without cost-share incentives, the economic viability of widespread conservation tillage systems in the Saginaw Bay area will be determined. Model farms will be characterized and an economic model developed to study the costs of the farms. Conventional, minimum, and no-till practices will be analyzed in terms of crop production on the model farms. A computer program will be developed, in conjunction with the economic model, to consider various inflation and interest rates, as well as changing commodity prices, in order to model future trends.

2. Aquatic Community Monitoring

Baseline data of the aquatic community was gathered during the Fall of 1979. efforts to implement agricultural best management practices are currently being intensified in hydrologically active areas (within 1/2 mile of each bank of the stream or drain). This is consistent with PLUARG management strategy recommendations for this area, which was identified as a major contributor of agricultural nonpoint loads to Saginaw Bay.

Resampling of identical stations will begin in the Spring of 1982. Data will be analyzed and compared with the baseline data collected in 1979. Biological sampling will include: periphyton, benthic organisms, macrophytes, and fish from tributaries and drains; and phytoplankton, zooplankton, benthic organisms, macrophytes, and fish from Saginaw Bay. This project will demonstrate that best management practices implemented in critical areas can have a beneficial impact on the aquatic community.

3. Water Quality Monitoring

PLUARG has determined that the most cost-effective approach for treating agricultural nonpoint source contributions is to implement best management practices in hydrologically active areas. The objective of the final work element is to demonstrate that implementation of best management practices, especially conservation tillage, in priority agricultural areas subject to wind and water erosion will result in measurable improvement of the water quality of Saginaw Bay.

Two demonstration plots will be located in the Wiscoggin Creek watershed on soils representative of the project area. These plots will be used to analyze the cost-effectiveness of conservation tillage versus conventional tillage, and to monitor drain runoff, wind transport, and incremental loadings of sediment and nutrients. Wiscoggin Creek will be monitored for suspended sediments, total phosphorus, dissolved phosphorus, ortho phosphorus, nitrate, nitrite, kjeldahl nitrogen, and ammonia.

Six sample sites will be established to determine the current loadings to Saginaw Bay. These will be compared with the loads developed by the Sea Grant program from 1973 to 1975. Parameters to be sampled are the same as for Wiscoggin Creek, with the addition of dissolved oxygen. The loadings will be incorporated into the Saginaw Bay nutrient model which will be adjusted for the zone of the bay adjacent to the project area. The model will determine the water quality impacts associated with existing agricultural loadings and impacts associated with the reduced loads based upon information from the treated area.

The East Central Michigan Planning and Development Region has developed a strategy to address their nonpoint source problem which mirrors PLUARG's recommendations concerning treatment of high priority areas with best management practices. The regional staff hopes to demonstrate to the agricultural producer, the state, and local units of government that the water quality of Saginaw Bay can be significantly improved by implementing best management practices in hydrologically active areas. Producers will be informed of the savings associated with minimizing soil erosion and will be encouraged to implement conservation tillage practices based on the results of this project. Government units will be requested to develop tax incentives and to enact legislation to further assist individuals in implementing these practices.

The Long Term Agreement Program

The Food and Agriculture Act of 1977 directs the ASCS to place greater emphasis on long-term conservation problems. Farmers interested in improving their entire farm over several years may participate in the Long Term Agreement Program, in which they agree to follow a comprehensive conservation plan in return for a guaranteed commitment of ACP funds and SCS technical assistance. The law requires county committees to provide more funding for enduring conservation and environmental practices, rather than for production-oriented practices. Many county committees have responded by devoting more cost-sharing dollars to practices that will enhance water quality.

The Agricultural Conservation Program, in conjunction with technical assistance from the Soil Conservation Service, the Forest Service, and agricultural extension services, is an effective means of implementing many PLUARG recommendations at the local level, especially in the areas of sediment control from agricultural land use.

RURAL CLEAN WATER PROGRAM

Section 208(j) of the Federal Water Pollution Control Act, as amended, authorizes the Secretary of Agriculture, with the concurrence of the EPA Administrator, to establish and administer a program to enter into 5 to 10 year contracts with owners or operators of rural lands "for the purpose of installing and maintaining measures incorporating best management practices to control nonpoint source pollution." An additional requirement is that BMPs must be contained in certified and approved Water Quality Management Plans.

The Agricultural Stabilization and Conservation Service (ASCS) has responsibility for administering the Rural Clean Water Program which has received initial funding from Congress for FY 80 on a special one-year basis as part of the USDA budget separate from 208(j). At the time of this review (February, 1980), final regulations had not been published, but were expected to be available in the near future.

The Saline Valley Project

The Mill Creek (tributary to the Huron River) and Saline River (tributary to the River Raisin) watersheds in southeastern Michigan have recently been designated as project areas under the Rural Clean Water Program. The Saline Valley Project is one of 13 pilot conservation projects selected nationwide, and has received initial funding of roughly $2.5 million. It is expected to run over the next five to six years.

The Mill Creek and Saline River watersheds are predominately agricultural in land use. They are tributary to heavily-used, polluted waters. Both the Huron River and River Raisin are public drinking water sources and are extensively used for partial and total body contact. The project area was identified as southeast Michigan's most concentrated source of rural nonpoint pollution in the Southeast Michigan Council of Government's "208 Water Quality Management Plan." A number of problems currently exist, including areas subject to inordinate amounts of sedimentation, an area prone to extreme wind erosion, cases of road and streambank erosion, and many problems with animal waste management. The area also has a variety of soil, slope and drainage characteristics.

The objectives of the project are as follows:

1. To improve water use in Mill Creek and the Saline River for recreational and drinking purposes and to reduce sediment collection in impoundments.

2. To meet state water quality standards and areawide water quality goals in the project area.

3. To reduce nonpoint source contributions to Lake Erie from the project area to levels consistent with goals set forth by the International Joint Commission.

4. To meet Soil Conservation District goals for application of best management practices to the extent that they contribute to improve water quality in the project area.

5. To achieve a functional, cooperative and continuing institutional program for solving water quality problems in the project area.

6. To acquaint local and state level funding bodies of the potential of local agencies to fulfill the nonpoint source control requirements as set forth in approved water quality plans.

A number of pollution abatement practices have been selected for implementation under this program. All of the BMPs were previously identified in the 208 planning process as components of a comprehensive water quality management plan. Practices include strip cropping, minimum tillage, construction of debris basins, and livestock exclusion, among other things.

Consistent with PLUARG's recommendations, the Saline Valley Project will reduce the amount of nutrients (especially phosphorus), sediment, and fecal coliform entering Lake Erie. Reduced levels of pesticide contamination are also expected. The project is a good example of the type of nonpoint program recommended by PLUARG to achieve individual lake target phosphorus loads. Final results are expected to exceed Lake Erie phosphorus loading reductions substantially, assuming total compliance by landowners. Water quality in-stream, as well as nearshore Lake Erie, will be improved for drinking water supplies, total body contact, and recreational activity. Although no attempt was made to quantify cost-effectiveness, it is certain that the objectives are manageable and will have benefits to a large population of users.

NATIONWIDE URBAN RUNOFF PROGRAM

EPA is continuing its efforts to control nonpoint source pollution under the Nationwide Urban Runoff Program. As discussed in the first Post-PLUARG report, the program lists the following objectives (EPA, 1978):

1. To ascertain "what is known about urban runoff mechanisms, problems and controls" and present "a holistic view of the current state of the art and a strategy for action."

2. To present findings to Congress on the nature, crisis and severity of urban runoff problems and opportunities for control (i.e., descriptions of control measures will be included).

In FY 79-80, EPA will be funding 30 urban storm runoff prototype projects nationwide with 208 grants. The projects will test various best management practices (e.g., street sweeping, detention basin storage) and determine the resultant impact on water quality. Projects will generally last three years, with funding on a year-to-year basis.

By the end of FY 82, EPA hopes to have developed a number of effective control measures. The program will culminate with a report to Congress in 1983 on effects, causes and controls, and will continue thereafter to assure implementation.

THE SOIL AND WATER RESOURCES CONSERVATION ACT

The Soil and Water Resources Conservation Act (RCA) of 1977 (P.L. 95-192) was passed by Congress "(t)o provide for furthering the conservation, protection, and enhancement of the Nation's soil, water, and related resources for sustained use." The Act requires USDA conservation programs to be responsive to the long-term needs of the nation. An appraisal of and program plan for soil and water conservation were required to be developed by December 31, 1979. The appraisal and program plan are to be updated at five-year intervals.

A draft Appraisal and Program Report have recently been made available for public review and comment (USDA, 1980). The draft Appraisal discusses the status, conditions, and trends of the nation's soil, water, and related resources and presents a demand analysis for the resources. Data were analyzed relating to resource supplies and demands in terms of soil resource quantity and quality, water quality conservation and supply, fish and wildlife habitat, upstream flood damages, energy conservation and production, and related natural resources. Of particular interest are the analyses concerning soil resources, water quality, and fish and wildlife habitat (specifically, wetlands).

Objectives proposed for nondegradation of soil resources, based largely upon factors contained in the Universal Soil Loss Equation, include the following:

1. On agricultural lands where erosion is currently less than the T value,[1] maintain conditions so that erosion does not exceed T value.

   On lands presently eroding at rates greater than the T value and less than 14 T/A/Y (tons per acre per year), utilize the most cost-effective approach to reduce erosion to a level approaching the T value.

   Where erosion exceeds 14 T/A/Y, reduce it to T value.

2. Minimize conversion of prime farmlands to other uses.

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[1] T value: Soil loss tolerance is defined as the maximum rate of annual soil erosion that will permit a high level of cropland and rangeland productivity to be obtained economically and indefinitely. For cropland, forest land, pastureland, and native pasture, the estimated average is 5 tons per acre per year. For rangeland, the estimated average is 2 tons per acre per year.

Proposed activities to accomplish the objectives include the following:

1. Utilize data on soil and water resources to identify priorities to be addressed by conservation programs.

2. Provide land owners with information and assistance to evaluate and implement conservation needs.

3. Install conservation practices on 141 million acres of cropland nationwide losing in excess of 5 tons of soil per acre per year.

The aforementioned objectives and activities are particularly relevant to the following PLUARG recommendations:

> "...that erosion and sediment control programs be improved and expanded to reduce the movement of fine-grained sediment from land surfaces...;
>
> ...(retain) for agricultural purposes...those farmlands which have the least natural limitations for this use;
>
> ...(develop) regional priorities for implementing management plans...;
>
> ...(strengthen and expand) existing technical assistance and extension programs dealing with the protection of water quality, including rural...land management practices."

Objectives proposed for water resources from the RCA draft Appraisal and Program Report include the following:

1. Approach zero discharge of toxic pollutants at the earliest date possible.

2. Minimize loadings of organic waste (e.g., animal manure, urban sewage and sludge applied as fertilizer) by focusing efforts on critical areas to:

(a) reduce loadings of animal waste 60 percent and total organic waste loadings by 40 percent from the 1977 level;

(b) emphasize reductions in critical areas above lakes and reservoirs.

3. Reduce nutrient and dissolved solids loadings from agricultural sources nationally by 30 percent.

4. Where sediment prevention is critical to the protection of surface waters, reduce sediment by the amount necessary to achieve the designated uses as determined by the states.

Activities proposed to accomplish the objectives include the following:

1. Research to develop and transfer cost-effective nonpoint pollution control technology.
2. Elimination of excessive applications of nutrients and pesticides, use of alternative chemicals, etc.
3. Runoff and control measures to control pollutants typically attached to soil.
4. Animal waste control measures.
5. Irrigation water management; tailwater recovery; water conservation.

These activities and objectives are consistent with PLUARG recommendations that:

> "...actions be taken to reduce inputs of toxic substances...;
>
> (c)onsideration (be given to)...all potential nonpoint source problems related to agricultural practices, including erosion, fertilizer and pesticide use, livestock operations and drainage..."

Additionally, PLUARG concluded that future research was needed on remedial measures and their cost-effectiveness.

The objectives proposed under the analysis of fish and wildlife habitat include reducing the net loss of wetlands resulting from agricultural uses to zero. PLUARG recognized the unique pollution-reduction capabilities of wetlands and also recommended their preservation.

Seven alternative strategies to accomplish the objectives proposed for each resource area are presented in the draft Appraisal and Program Report. Detailed studies of these strategies will be made during and subsequent to the public review and comment period which runs through March 28, 1980.

In comparison with the rest of the nation, the Great Lakes region is already advanced in recognizing the necessity for, and implementing, both physical and cultural practices for nonpoint source control. As previously discussed, the Wisconsin Nonpoint Source Water Pollution Abatement Program and the Lake Erie Wastewater Management Study are currently addressing the problem of nonpoint source pollution abatement in different sections of the basin. Section 108(a) Demonstration Projects have provided the opportunity to evaluate a wide range of land management practices in terms of their effectiveness in reducing nonpoint source problems. Specifically, studies at Black Creek, Allen County, Indiana, and Washington County, Wisconsin, have focused on best management practices for agricultural activities and rural sediment control.

Additional efforts have included work with models to investigate nonpoint source pollution and methods of abatement, as well as to identify critical areas in the Great Lakes basin watersheds. The "overview modeling" process, for example, has been used to identify the most cost-effective mix of point and nonpoint controls for the basin. The research survey, discussed subsequently in this report, found a considerable number of ongoing studies into the causes and control of nonpoint pollution located in the Great Lakes region.

UPDATE ON 208 WATER QUALITY MANAGEMENT PLANNING

Since 1973, 208 water quality management agencies have identified regional water quality problems, developed solutions and identified units of government responsible for implementation of solutions. During FYs 80-83, emphasis will be placed on filling in the gaps in areawide water quality management plans. This will be accomplished primarily through the use of prototype problem-solving projects, with the U.S. Environmental Protection Agency (EPA) providing funding, technical expertise and information transfer. The Nationwide Urban Runoff Program, previously discussed, is illustrative of this new, more active management approach.

EPA has established four priority problem areas to be addressed in FYs 80-84: urban storm runoff, nonpoint sources, groundwater quality, and waste treatment facilities. Generally, highest funding priority will be assigned to programs addressing urban stormwater runoff, agricultural runoff, and groundwater protection. Programs involving nonpoint source pollution from construction, mining, or silvicultural activities will generally receive secondary priority. EPA anticipates completion of the 208 grant program by FY 83, given adequate funding for FYs 81, 82 and 83. At that time, EPA will decide on the future direction of the Water Quality Management Program.

Table 1 shows the current status of the water quality management plans being prepared by each of the agencies carrying out water quality planning in the Great Lakes basin. To date, 23 of the completed plans have received state certification. Of these, 17 have received EPA approval as well.

Great Lakes Basin Commission 208 Report Bibliography

In an effort to maximize the utilization of 208 planning information in other planning and management activities in the basin, a key-word coded bibliography of 208 reports is being developed by the Basin Commission staff. The bibliography of all water quality management planning reports in the Great Lakes basin is being entered into the Basin Commission's computer. Initially, the bibliography will contain between 700 to 800 reports, with additions made as necessary. This information base will be available for use by the Great

TABLE 1

STATUS OF 208 PLANNING IN THE GREAT LAKES BASIN

AGENCY	DESIGNATION DATE	FINAL PLAN DATE	STATE CERTIFICATION DATE	EPA APPROVAL
ILLINOIS -				
NIPC Northeastern Illinois Planning Commission	6/13/75	5/79		
INDIANA -				
ISPCB Indiana Stream Pollution Control Board	5/28/76	5/80*	5/80*	6/80*
MACOG Michiana Area Council of Governments	6/11/75	5/78	8/79	10/79
NIRPC Northwestern Indiana Regional Planning Comm.	6/06/75	5/78	8/79	9/79
MICHIGAN				
CUPPAD Central Upper Peninsula Planning & Development Regional Commission	5/28/76	3/78	9/78	1/79
ECMPDRC East Central Michigan Planning & Development Regional Commission	6/06/75	9/78	10/78	2/79
EUPRPDC Eastern Upper Peninsula Regional Planning & Development Commission	5/28/76	9/78	10/78	3/79
GLS-V Genesee-Lapeer-Shiawassee Region V Planning Commission	6/06/75	9/78	10/78	2/79
NEMCOG Northeast Michigan Council of Governments	5/28/76	9/78	10/78	2/79
NMRPC Northwest Michigan Regional Planning & Development Commission	5/28/76	12/78	7/78	11/78
REG.II Region II Planning Commission	6/06/75	9/78	11/78	3/79

TABLE 1 (cont'd.)

STATUS OF 208 PLANNING IN THE GREAT LAKES BASIN

AGENCY	DESIG-NATION DATE	FINAL PLAN DATE	STATE CERTI-FICATION DATE	EPA APPROVAL
MICHIGAN (cont'd.)				
SMPC Southcentral Michigan Planning Council	6/06/75	10/78	5/78	9/78
SEMCOG Southeast Michigan Council of Governments	6/06/75	8/78	9/78	1/79
SMRPC Southwestern Michigan Regional Planning Comm.	5/28/76	4/78	9/78	1/79
TCRPC Tri-County Regional Planning Commission	6/19/75	4/78	2/78	7/78
WMRPC West Michigan Regional Planning Commission	6/19/75	2/78	5/78	9/78
WMSRDC West Michigan Shoreline Regional Development Commission	6/19/75	9/78	11/78	3/79
WUPPDRC Western Upper Peninsula Planning & Development Regional Commission	5/28/76	9/78	10/78	2/79
MINNESOTA				
MPCA Minnesota Pollution Control Agency	5/28/76	1/80	2/80	4/80*
NEW YORK				
NYSDEC New York Department of Environmental Conservation	5/28/76	3/79	12/79	
CNYRPDB Central New York Regional Planning & Development Board	6/09/75	4/79	1/80	3/80*
ENCRPB Erie-Niagara Counties Regional Planning Board	6/23/75	2/79	1/80	4/80*

TABLE 1 (cont'd.)

STATUS OF 208 PLANNING IN THE GREAT LAKES BASIN

AGENCY	DESIG-NATION DATE	FINAL PLAN DATE	STATE CERTI-FICATION DATE	EPA APPROVAL
OHIO				
OEPA Ohio Environmental Protection Agency	5/28/76		3/80[a]	
NOACA Northeast Ohio Areawide Coordinating Agency	6/16/75		10/79[b]	
TMACOG Toledo Metropolitan Area Council of Governments	6/25/74	1/77	11/78	3/79
PENNSYLVANIA				
PDER Pennsylvania Department of Environmental Resources	6/01/76			
WISCONSIN				
WDNR Wisconsin Department of Natural Resources	5/28/76	/80[c]	/80[c]	/80[c]
FVWQPA Fox Valley Water Quality Planning Agency	6/19/75	6/79	7/79	
SEWRPC Southeast Wisconsin Regional Planning Comm.	6/06/75	8/79	12/79	

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* Expected Date

a. The OEPA Plan is composed of 13 separate basin reports. Some have already been certified. All 13 are expected to be certified by 3/80.

b. The Cuyahoga portion of the Plan is expected to be certified 2/80.

c. The WDNR Plan is composed of management plans from 21 different planning areas. The status of reports from planning areas within the basin is shown on the following page:

TABLE 1 (cont'd.)

STATUS OF 208 PLANNING IN THE GREAT LAKES BASIN

Planning Area	Final Plan Date	State Certification Date	EPA Approval
Upper Green Bay	4/80*		
Wolf River Basin	4/80*		
Upper Fox River Basin	8/79	12/79	
Lower Fox River Basin	8/79 (Nonpoint source element only)	12/79 (Nonpoint source element only)	
Twin-Door-Kewaunee	9/80*		
Manitowoc River Basin	8/79	9/79	9/79 (Conditional approval of nonpoint source element only)
Sheboygan River Basin	4/80*		
Upper Milwaukee River Basin	4/80*		
Southeast Wisconsin Regional Planning Area	8/79	12/79	

Lakes National Program Office, as well as by planning and management agencies and the general public. The bibliography should be completed and ready for outside use by September, 1980.

A complete list of the keywords presently in use is included in Table 2. Reports can be selectively retrieved from the system by: (1) state, (2) lake, (3) river basin group, (4) agency, or (5) topic (key word). Multiple specification retrievals are also possible. Appendix C contains an example of a partial retrieval utilizing the keywords: "Remedial Measures", "Unit Area Loads/Models", and "Costs" under "Nonpoint Sources".

FIVE YEAR STRATEGIES

According to Water Quality Management regulations (40 CFR Part 35, Subpart G [1979]), each state must prepare and update annually a five-year strategy for controlling pollution from point and nonpoint sources. In some instances, designated 208 areawide planning agencies prepare individual five-year strategies for input to the overall state report. A review of programs developed by state and areawide planning agencies in the basin (Attachment 2) identified a number of study proposals with particular relevance to Great Lakes issues and problems. As results become available from these regional studies and demonstrations, it will be important to incorporate their findings into the evolution and maintenance of a comprehensive management strategy for the Great Lakes.

U.S. AIR QUALITY CONTROL PROGRAMS - IMPLICATIONS FOR IMPROVEMENT OF GREAT LAKES WATER QUALITY

The Great Lakes are particularly susceptible to atmospheric inputs of pollution. The following factors have been identified as contributing to their sensitivity:

- the lakes are close to and often downwind of major sources of pollution;

TABLE 2

208 BIBLIOGRAPHY
KEY WORD DICTIONARY

- 100 Point Sources
  - 110 Sources
  - 120 Projections
  - 130 Alternatives
  - 140 Recommendations
  - 150 Facility Plans
- 200 Nonpoint Sources
  - 210 Problems
  - 220 Remedial Measures
  - 230 Recommendations
  - 240 Unit Area Loads/Models
  - 250 Other
  - 260 Costs
- 300 Toxic Substances
  - 310 Problems
  - 320 Special Studies
  - 330 Management Programs
- 400 Atmospheric Loads
- 500 Great Lakes Issues
  - 510 CZM
  - 520 Great Lakes Water Quality
    - 521 Recommendations
- 600 Land Factors
  - 610 Inventory
  - 620 Projections
  - 630 Soils/Geology
- 700 Population
  - 710 Current
  - 720 Projected
- 800 Sludge
  - 810 Quantity
  - 820 Disposal Plan
  - 830 Alternatives/Techniques
- 900 River and Lake Basin
  - 910 Water Quality Assessments
  - 920 Detailed Studies
  - 930 Modeling Activities
  - 940 Wast Load Allocations
  - 950 Other
- 1000 Biological Studies
- 1100 Other Special Studies
  - 1110 Groundwater
  - 1120 Water Conservation
  - 1130 Phosphorus
  - 1140 Rainfall
  - 1150 Inland Lakes
  - 1160 Maps
- 1200 Wetlands
- 1300 Dredging
- 1400 Management Plan
  - 1410 Existing Framework
  - 1420 Alternatives
  - 1430 Recommendations
  - 1440 Objectives
  - 1450 Other
    - 1451 Economics
    - 1452 Implementation
    - 1453 Legislation/Legal Issues
    - 1454 Report Summaries
- 1500 Public Participation
- 1600 Work Program/5-yr Strategy
  - 1610 Annual Work Program
  - 1620 Five Year Strategy
- 1700 Other
  - 1710 Environmental Assessment

- the lakes have comparatively long retention times, resulting in relatively high concentrations of even low level inputs;

- atmospheric inputs to the Great Lakes are large and are readily borne by runoff;

- the low suspended sediment load per unit volume to each of the Great Lakes, except Lake Erie, may contribute to their sensitivity. Higher volumetric sediment loads may provide more opportunity for sorption of toxics and subsequent settling out of the water column. Higher solids loads may also serve to "dilute" toxic concentrations in bottom sediments; and

- The Great Lakes region has considerable potential for further industrial development with associated deleterious effects.

The significance of atmospheric pollutant inputs on Great Lakes water quality makes consideration of air pollution control programs a key element in the development of a Great Lakes environmental management strategy.

The Great Lakes Water Quality Agreement of 1978 provided for consideration of atmospheric inputs in Article VI(1)(L), stating that "(i)n cases where significant contributions to Great Lakes pollution from atmospheric sources are identified, the Parties agree to consult on appropriate remedial programs." Similar concern was expressed in PLUARG's recommendation that "the role of atmospheric inputs should be considered in the evaluation of Great Lakes pollution, with special consideration given to the sources of major atmospheric pollutants."

The U.S. national air pollution control effort embodies two complementary approaches: the National Ambient Air Quali"the role of atmospheric inputs should be considered in the evaluation of Great Lakes pollution, with special consideration given to the sources of major atmospheric pollutants."

The U.S. national air pollution control effort embodies two complementary approaches: the National Ambient Air Quality Standards (NAAQS) program and the National Emissions Standards for Hazardous Air Pollutants (NESHAPS) program. Program regulations include provision for coordination with areawide water quality management planning ("208") programs. However, these provisions have generally not been implemented. Most inter-program coordination presently takes place at the federal level through the regional Intermodal Planning Groups.

Because U.S. air and water pollution control programs have evolved independently, it may be extremely difficult to reconcile the two in areas of common concern (e.g., toxic substances pollution via atmospheric deposition). Attachment 3, "U.S. Air Quality Control Programs - Implications for Improvement of Great Lakes Water Quality," examines ongoing air quality control programs, focusing on the statutory and regulatory requirements for air and water pollution control program coordination. Air quality programs in each of the Great Lakes states are reviewed. Finally, the efficacy of air pollution control programs in reducing PCB inputs to the lakes is examined.

STATUS OF THE PHOSPHORUS MANAGEMENT STRATEGIES TASK FORCE RECOMMENDATIONS

In the 1978 Great Lakes Water Quality Agreement between the United States and Canada, the two governments tentatively agreed to the following target loads for phosphorus entering Great Lakes surface waters:

Basin	Target Load (metric tons/yr)
Lake Superior	3,400
Lake Michigan	5,600
Main Lake Huron	2,800
Georgian Bay	600
North Channel	520
Saginaw Bay	440
Lake Erie	11,000
Lake Ontario	7,000

Annex 3 of the Agreement also specifies that the U.S. and Canadian federal governments, "in cooperation with the State and Provincial Governments, shall ...confirm the future phosphorus loads, and based on these establish load allocations and compliance schedules." The confirmed set of phosphorus loading objectives is due by May 22, 1980.

The Phosphorus Management Strategies Task Force (PMSTF), a joint Water Quality Board-Science Advisory Board work group, is currently reviewing the methodology utilized in determining the loading objectives and the programs and technology necessary to meet the objectives. The final report of the Task Force was expected in January, 1980, but has not yet been completed. However, several preliminary subreports, which presumably will form the basis of the final report, have been developed. These are listed in Table 3.

The Task Force completed an Interim Report for the International Joint Commission (IJC) in December of 1979. The following is a summary of the major conclusions reached in this report. It should be noted that these are only preliminary findings which may be modified as the Task Force continues its work.

Phosphorus Loadings

Total phosphorus loads to the Great Lakes (for 1976), considered by the Task Force to be the best estimates, given the available data, are presented in Table 4 (PMSTF, 1979). These estimates are based on data from a number of different sources and include any corrections or updates to the data base not available in previous estimates. These estimates were judged to be within 10 to 20 percent of the actual load for the sources included in the estimates.

Several factors were not included in the Task Force's estimate of variability. These included high flow event sampling data (except for Lake Erie) and consideration of shoreline erosion contributions. In the case of shoreline erosion, the total phosphorus loads from this source were given (see Table 4), although they were not counted as part of the total load.[1]

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1. The contribution of shoreline erosion was excluded based on the assumption that it is primarily a source of unavailable phosphorus.
2. These figures are also based on an accumulation of information from many summary sources. The majority of the information was available for water years 1975 and 1976.

TABLE 3

DOCUMENTS RECEIVED FOR FINAL REPORT OF THE PHOSPHORUS MANAGEMENT STRATEGIES TASK FORCE AS OF DECEMBER 12, 1979

Chapter I. BACKGROUND

- The Laurentian Great Lakes - Ecological Perspectives - 5 pages. (Beeton - February 19, 1979)
- Phosphorus as Related to Great Lakes Eutrophication - 5 pages. (Beeton - April 3, 1979)

Chapter II. PHOSPHORUS TARGET LOADS

- Development of Target Loads - 23 pages. (Salbach & Rast)

Chapter III. EVALUATION OF PHOSPHORUS INPUTS TO THE GREAT LAKES

- PLUARG Report on Differences in Great Lakes Phosphorus Load Estimates - 27 pages. (Rast & Gregor - February, 1979)
- Analysis of Phosphorus Loads - 6 pages. (Mancini)
- • Draft of Chapter III - (Mancini et al.) - 25 pages, December 6, 1979.

Chapter IV. IMPACT OF PHOSPHORUS LOADS ON PHOSPHORUS, ALGAL, OXYGEN LEVELS IN GREAT LAKES

- Review and Evaluation of Models - 30 pages. (O'Connor)
- • Revised Chapter IV - Review and Evaluation of Models - 38 pages. (O'Connor - November 28, 1979)

Chapter V. COSTS AND TECHNOLOGIES OF PHOSPHORUS CONTROL

- Outline - Costs and Technology for Phosphorus Control - 7 pages. (Schmidtke)
- Point Sources - 11 pages. (Van Fleet - November 1, 1979)
- Detergent Phosphorus Substitutes (Carlson - November 1, 1979)

TABLE 3 (cont'd.)

Chapter V. (cont'd.)

- Gross Estimates of POTW Phosphorus Load to the Great Lakes and Cost of Alternative Strategies (U.S. EPA - MERL)
- Phosphorus Removal Using Land Treatment Systems - 13 pages. (Loehr - August 17, 1979)
- Sludge Production as a Result of Phosphorus Removal - 16 pages. (Loehr & Naylor - September 17, 1979)
- Management of Nonpoint Sources of Phosphorus - 17 pages. (Bangay - October, 1979 - revised draft)
- • Chapter V - Costs and Technologies of Phosphorus Control (Schmidtke) - preliminary consolidation of above reports - December 5, 1979.

Chapter VI. STRATEGIES AND RECOMMENDATIONS

- Strategies for Assessing the Social and Economic Impacts of Great Lakes Phosphorus Management - 13 pages. (Bangay & Peskin - October, 1979)

Chapter VII. SUMMARY

Table 5 compares the Task Force's initial estimates with annual total phosphorus loads for the mid-1970s compiled by Chapra and Sonzogni (1979).[2] As shown, the figures are very close in value. In fact, they are within the ±20 percent error noted previously.

Differences between the two estimates may be largely explained by the time frame difference (1976 versus mid-1970s). As discussed in Sonzogni *et al.* (1980), considerable differences exist from year to year in tributary flow and, therefore, the phosphorus load.

Not surprisingly, the PMSTF loads are, with the exception of Lake Erie, identical to the loads reported in PLUARG. The difference in the Lake Erie load can be explained by a revised estimate of point source inputs, as explained in Sonzogni *et al.* (1980). Overall, given the update for Lake Erie, the PMSTF appears to have agreed that the loads developed by PLUARG (the U.S. loads were compiled by GLBC staff) are the best available at this time.

Phosphorus Availability

The Task Force is also evaluating the question of phosphorus availability and its significance in formulating management strategies for the Great Lakes. A review of recent studies concerned with phosphorus availability highlighted the paucity of research in this area. Additional information is needed on the relationship of the operationally-defined forms of phosphorus (non-apatite inorganic P, organic P, apatite inorganic P, NaOH extractable P, etc.) and their relation to the form utilized by algae. Studies are needed to compare chemical and biological methods of measuring phosphorus availability and to determine the correlation between algal bioassay data and lake biomass response. Additional research efforts are also needed to determine the significance of the proximity of the phosphorus source to the receiving water in terms of in-lake phosphorus availability.

Although it did not arrive at a firm conclusion regarding its significance, the PMSTF has clearly highlighted the importance of considering phosphorus availability in management decisions. They did not indicate that evidence to date suggests that a large portion of the phosphorus delivered to

TABLE 4

"BEST" ESTIMATE OF 1976 PHOSPHORUS LOAD
(metric tons)

Lake	Direct Municipal	Direct Industrial	Tributary* Total	Atmosphere	Urban Direct	Upstream Load	Total	Shoreline Erosion
SUPERIOR	72	103	2,455	1,566	16	--	4,212	3,800
MICHIGAN	1,041	38	3,596	1,682	--	--	6,357	3,700
HURON	126	38	2,901	1,129	16	657	4,867	794
ERIE	6,292	275	9,960	774	44	1,080	18,425	10,526
ONTARIO	2,093	82	4,047	488	324	4,769	11,803	1,280

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* consists of indirect point sources and nonpoint sources in tributary basin.

TABLE 5

A COMPARISON OF ESTIMATES OF TOTAL PHOSPHORUS LOADING TO THE GREAT LAKES
(metric tons/year)

	Total Loading Excluding Shoreline Erosion		Shoreline Erosion	
Lake	PMSTF (1976)	Chapra & Sonzogni (mid 1970s)	PMSTF (1976)	Chapra & Sonzogni (mid 1970s)
SUPERIOR	4,212	4,000	3,800	3,800
MICHIGAN	6,357	6,950	3,700	3,700
HURON	4,867	5,472	794	700
ERIE	18,425	19,047	10,526	10,450
ONTARIO	11,803	10,444	1,280	1,300

the Great Lakes via tributaries is not biologically available. This point was made in the PLUARG report as well as in Sonzogni et al. (1980). While it is agreed that additional research is needed on the biological availability of phosphorus, there is enough information in existence to indicate that fine-tuning of our phosphorus management strategies must include the fact that a significant portion of the nonpoint source phosphorus input is in a non-available form. Moreover, it would seem to indicate that our current emphasis on controlling point sources appears to be a correct one. Some additional information on the effect of phosphorus availability on management strategies is being prepared as part of the Basin Commission's Great Lakes Environmental Planning Study (GLEPS). Preliminary information is being supplied to the PMSTF.

Assessment of Phosphorus Models

As one of its work efforts, the Task Force is conducting an assessment of the models used in the development of the target loads proposed in the Agreement. Based on an initial assessment, it has concluded that the models can provide reasonable estimates of the total phosphorus concentrations for Lake Ontario and dissolved oxygen concentrations for Lake Erie. Uncertainties in the model structure are in the range of 10 to 30 percent, insufficient to preclude their use in the formulation of alternate management strategies.

Point Source Control

One of the major objectives of the PMSTF's study is to determine whether or not it would be advisable to require phosphorus removal at municipal treatment plants in the Erie and Ontario basins to the 0.5 mg/L P level. At the present time this question is unresolved. However, preliminary indications are that across-the-board requirements for the 0.5 mg/L limit would not be practical. Rather, it appears that a stepped or staged approach will be advocated, wherein the 1.0 mg/L limit is emphasized for the time being and the effects of this action evaluated. This might be accomplished by using a demonstration program whereby the effect of phosphorus control on a portion of the Great Lakes (e.g., Saginaw or Green Bay which have relatively short response times) could be carefully evaluated. The demonstration program might include testing of different removal efficiencies at municipal treatment plants. Another possibility would be to encourage an intermediary control level between 1.0 or 0.5 mg/L P, since some plants can achieve somewhat less than 1.0 mg/L simply by efficient plant operation (i.e., no additional cost is likely to be involved). While this should surely be encouraged, the reduction in loading which would be achieved is small.

The above possibilities are consistent with the Great Lakes Basin Commission's recommendation (GLBC, 1979a; GLBC 1979b) for phosphorus control at municipal plants. A staged implementation program designed to meet regional needs could provide the feedback information necessary to fill the gaps in the current status of our knowledge regarding effects, costs, and benefits of various phosphorus control strategies. In this manner, the most cost-effective control measures could be identified and recommended for implementation.

Nonpoint Source Control

The PMSTF is also considering how, or to what extent, nonpoint sources should be reduced. At present, no information is available from the PMSTF which might result in their reaching a conclusion different from the PLUARG findings. Furthermore, the IJC's response to the PLUARG recommendations may have a bearing on any recommendations on nonpoint source control that the PMSTF may make.[1] It is thus expected that the nonpoint source control recommendations of the PMSTF will be similar to the Basin Commission's recommendation regarding implementation of a nonpoint source control program (i.e., implementation of essentially voluntary measures that will not require large public or private expenditures).

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[1] At the time of this writing, the IJC review was complete but not yet available.

CHAPTER 3

POLLUTANT LOADINGS TO THE LAKES

UPDATE ON TRIBUTARY MONITORING PROJECTS

PLUARG's final report to the IJC underscored the need for expanding tributary monitoring programs to improve the accuracy and precision of load estimates (IJC, 1978). Additionally, such studies would serve to monitor the effectiveness of point and nonpoint source pollution control programs, aid in setting priorities for future control programs, and provide baseline data by which the effectiveness of future programs may be assessed. At this time, a number of tributary monitoring programs are underway in the basin.

Ohio

The river mouth sampling program for Ohio tributaries to Lake Erie is approximately 50 percent complete (as of February, 1980) (Baker, 1980). The sampling program will include the spring runoff events of 1980. In this study, storm event transport of sediments, nutrients and metals are being monitored by the USGS at 13 river mouth stations. Sample analysis is being conducted at the Heidelberg Water Quality Laboratory. The resulting chemical data, along with the associated stream flow data, will be used to calculate annual loadings of materials to Lake Erie from Ohio streams. Data from the program will be incorporated into the USGS annual publication of Water Resources Data for Ohio. The data will also be placed in the STORET system, making it available for use by a wide range of agencies, including local and regional planning authorities.

An important part of the Heidelberg Water Quality Laboratory's Post-PLUARG work is to generate additional information on the biological availability of the phosphorus associated with the tributary load. Apparently no information has been generated to date on phosphorus availability. Hopefully this information will be forthcoming in the near future.

As previously mentioned, water quality monitoring is also underway in the upper Honey Creek watershed to determine the effect of agricultural pollutant abatement demonstration projects on water quality. The Heidelberg Water Quality Laboratory, under contract with the U.S. Army Corps of Engineers, is conducting a biological survey at six points within the upper drainage reaches to provide baseline data for subsequent studies of the effect of widespread adoption of no-till practices on the stream community structure. The study is scheduled for completion by July 1, 1980, and will also include information on phosphorus loading from rural septic systems.

The Heidelberg Water Quality Laboratory is also under contract with the U.S. Army Corps of Engineers to continue their detailed stream transport studies of nutrients and sediments at six locations in the Sandusky River basin for the 1980 water year. A component of the third phase of the Lake Erie Wastewater Management Study (LEWMS), data will be utilized to evaluate the water quality effects of tillage demonstration projects and modeling efforts underway in the basin. Storm transport studies are also scheduled to be conducted during spring runoff events at Bean Creek, the West Branch of the Rocky River, and the Ottawa River (three of the five additional basins to be studied under Phase III of LEWMS).

The final report of Heidelberg College Water Quality Laboratory's two and one-half year study for EPA on "Fluvial Transport and Processing of Sediments and Nutrients from Nonpoint Sources" in northwestern Ohio and the Sandusky basin is currently in preparation. A detailed study of the data will be conducted utilizing the fluvial transport model developed by the U.S. Army Corps of Engineers. Annual variability in nutrient and sediment yields, sediment delivery ratios and variations in nutrient/sediment ratios will also be investigated.

Wisconsin

Another Post-PLUARG tributary monitoring program has recently been funded for Wisconsin. The activity is being carried out by the Wisconsin Department of Natural Resources (WDNR) in cooperation with USGS. The Water Chemistry Laboratory at the University of Wisconsin-Madison will also be utilized to determine the biological availability of phosphorus and the particle size distribution in the suspended solids of a select number of samples.

Runoff event and baseflow samples will be collected at the mouths of seven Lake Michigan tributaries: the East Twin, Pigeon, Branch, Manitowoc, Sheboygan, Cedar, and the Milwaukee. EPA is currently considering funding monitoring activities on the Fox and Menomonee rivers also. Water quality/ quantity monitoring will begin on the first group of tributaries within the next few months.

All of the tributaries included in the monitoring program drain land use activities identified as potential contributors of nonpoint source pollution. Large portions of all of the watersheds support agricultural activities (identified by PLUARG as the major diffuse source contributor of phosphorus). Additionally, the Pigeon River watershed is dominated by clay soils which were identified by PLUARG as contributing the greatest amounts of phosphorus. Monitoring of the Pigeon River will provide particularly valuable information on unit phosphorus loadings for agricultural activities on fine-textured soils.

1977-78 RIVER MOUTH LOADINGS

In 1978, the IJC published a report prepared by the Great Lakes Basin Commission staff for U.S. EPA, Region V, entitled "United States Great Lakes Tributary Loadings." In that report, a detailed analysis of 1975 and 1976 U.S. tributary loads was presented. Much valuable information was obtained from this work, but it was recognized that additional data for future years were needed to more fully understand the impact of tributary loadings. This became another task of the Post-PLUARG Agreement: to calculate tributary loads from U.S. tributaries for water years 1977 and 1978. Appendix D presents the results of the loading calculations which can be compared directly with Appendix A of Sonzogni et al. (1978). A more detailed analysis of these loads will be conducted under the second portion of the Post-PLUARG Agreement to be completed by September of 1980.

A quick examination of Appendix D will reveal that there are no loads for Lake Erie. As was discussed in Sonzogni et al. (1978), it is important to utilize the Lake Erie Wastewater Management Study (LEWMS) work in obtaining tributary loads for Lake Erie. Individual river mouth loads were not available from the U.S. Army Corps of Engineers at this time, but will be presented in the upcoming report.

Data Sources

River mouth loads were calculated using the best available concentration and flow information. Every effort was made to utilize all data available for any given tributary to maximize the confidence in a loading estimate. Primary sources of data included state water surveillance programs, U.S. Geological Survey programs, and other work done by universities and special state or federal projects.

In general, data on the four parameters considered were available for major U.S. Great Lakes tributaries. Appendix D indicates the number of flow and concentration data pairs that were used in each loading calculation.

The primary source of daily and mean annual flow information was U.S. Geological Survey Water Resources Data reports. Some state surveillance programs also collected flow data (generally at the time of the sample collection). These were used where appropriate.

Base Years

All loadings were calculated by water year as standardized by the U.S. Geological Survey.

Watershed Areas

In this report, tributaries and their watersheds have been organized according to individual tributaries, hydrologic areas, river basin groups, and lake basins following the procedure used in Subactivity 2-1 of U.S. Task D, PLUARG (Hall et al., 1976). Each of the 72 hydrologic areas consists of a single major watershed or a complex of small watersheds draining individual tributaries. Hydrologic areas are grouped into 15 larger river basin groups (River Group in Appendix D) which contain anywhere from one to eight hydrologic areas. Each lake basin consists of two or more river basin groups. A description of the U.S. tributaries, their organization and maps of their drainage basins has been previously recorded in Hall et al. (1976).

Additional information on the watershed areas used in this study may be found in Sonzogni et al. (1978). Watershed area measurements were obtained primarily from the Great Lakes Basin Framework Study, Appendix 1, "Alternative Frameworks". Additional drainage area information, especially for areas containing the smaller rivers, was obtained from a computerized list of watershed areas compiled for the Conservation Needs Inventory by the U.S. Soil Conservation Service.

Correcting Loads to the River Mouth

Not all chemical stations and flow gaging stations are located at the river mouth. In order to present a total river mouth load in these situations, it was necessary to adjust flow to account for the area below monitoring stations.

In order to adjust flow measurements to the river mouth, gage flow was multiplied by the ratio of the total drainage area over the gaged drainage area. For example, if a river drains a total area of 1,000 square kilometers, but the farthest downstream flow gage is located 15 river kilometers upstream from the mouth and accounts for only 900 square kilometers, the gaged flow would be multiplied by 1,000/900 or 1.11 to provide a corrected flow. All flows used in loading calculations in this report were corrected in this manner, if not already reported as accounting for the total watershed drainage area.

In most cases, chemical monitoring stations were located at or very near the river mouth. Consequently, no concentration adjustments were made; and it was assumed that concentrations at the mouth were the same as those measured at the monitoring station. An exception to this procedure occurred if the monitoring station was above a major impoundment. In those few cases, the load was calculated at the point above the impoundment.

Method of Calculating Loadings

Loadings for this report were calculated using the ratio estimator method, employing a computer program developed specifically for applying the calculation method (Clark, 1976). This method has been widely reviewed and is generally accepted by the Great Lakes research and surveillance community as the preferred and, importantly, standard method for calculating tributary loads. For a further explanation of the ratio estimator used, see Sonzogni et al. (1978).

The quantity of rainfall and runoff varies significantly from year to year and among the lakes. Because watershed yield is an important factor in determining the tributary load, runoff conditions should be examined in ascertaining the significance of the load. A detailed examination of flow variations will be presented in the next Post-PLUARG report. At present, it should be noted that the year 1975, and in particular 1976, were years of very high flows (relative to the long-term historical flow) for all of the lakes except Superior. 1977 was a very low flow year for all of the lakes. In 1978, flows returned to average or above average conditions.

In calculating river mouth loads, an understanding of the influence of high flow events is also crucial. For example, for tributaries draining into parts of Lake Erie it is clear that high flow events have a major impact on the total load of sediment and certain chemical substances. However, the relationship between flow and concentration varies widely over the U.S. Great Lakes basin. It should be noted here that all data, including high flow event data that were available, were used in calculating river mouth loads.

OVERVIEW MODELING ACTIVITIES

At the request of U.S. EPA's Great Lakes National Program Office, Basin Commission staff have proposed ways in which the overview modeling process developed as part of the PLUARG study (Johnson et al., 1978; Heidtke et al., 1979a) could be presented for use by local decision makers in choosing among alternative point and nonpoint pollution control strategies. The unique potential of this process for use as a planning tool in localized long-term watershed management, both within and outside the Great Lakes basin, is discussed in Attachment 4, "Methodology for Choosing Among Alternatives to Reduce Pollutant Contributions from Watersheds."

The overview modeling process has also recently been used to generate estimates of U.S. current and future total phosphorus and heavy metal inputs to the Great Lakes under a variety of management scenarios (Heidtke et al., 1979b; Heidtke et al., 1980). An updated information base was compiled for these studies, primarily from local water quality management ("208") plans.

Total Phosphorus Loadings

Results of the study on future U.S. phosphorus loadings reveal that achievement of a 1.0 mg/L total phosphorus effluent limitation at municipal sewage treatment plants (greater than 1 mgd) would result in almost a 60 percent reduction in U.S. municipal input of phosphorus between the mid-1970s and 1990. Although a gradual increase in the annual U.S. municipal load is expected between 1990 and 2000, the input should remain well below mid-1970 levels. Full implementation of the 1 mg/L phosphorus limitation was identified as the most critical step in a cost-effective reduction of phosphorus loadings to the Great Lakes.

Very little change is projected in the total phosphorus load contributed from rural runoff (assuming no additional runoff control measures are implemented). Based on projected land use changes, it is expected that the rural runoff load will exhibit a downward trend in the future with the greatest decrease expected in the Lake Erie basin. Remedial programs designed to reduce the input from rural runoff were studied and compared on the basis of cost-effectiveness (cost per metric ton reduction in lake loading). Voluntary sound management practices such as proper application of fertilizers and manure, general conservation plowing techniques, mulching, etc., were determined to be extremely cost-effective but generally unlikely to significantly reduce phosphorus loadings. More extensive control programs were not determined to be cost-effective. However, preliminary results from the Lake Erie Wastewater Management Study (LEWMS) have shown that costs may be much less and that a net benefit may result for some regions.

The study revealed that the phosphorus loading contributed by urban runoff will remain relatively constant over the next two decades (assuming no additional remedial measures are implemented). Mechanisms for controlling urban runoff were not found to be cost-effective in terms of the reduction achieved in the annual total phosphorus load to the Great Lakes. However, such programs may significantly reduce heavy metal loadings to the lakes.

Heavy Metal Loadings

The overview modeling process was used to generate annual loadings of lead, zinc, copper and cadmium to the Great Lakes from U.S. municipal point sources and land drainage. Estimates revealed that Lake Erie receives the largest input of heavy metals from municipal point sources and urban runoff, while Lake Michigan receives the greatest loading from rural land drainage.

Implementation of phosphorus control programs should result in increased metal removal efficiencies, significantly reducing heavy metal loadings to Lake Erie and Lake Ontario over the next few years. It is expected that by the year 1990 municipal inputs to these two lakes will be roughly 25 to 30 percent less than mid-1970 levels. Municipal inputs of heavy metals to Lakes Superior, Michigan and Huron are not expected to change significantly over the next two decades.

Heavy metal loadings from rural runoff are expected to remain relatively constant (assuming no additional remedial measures are implemented) over the next few years. Estimates obtained from running a low-cost, voluntary land management scenario indicate that metal inputs from rural land would be reduced by less than 7 percent. More extensive management practices result in an additional load reduction of less than 10 percent. Thus it appears that remedial programs to control rural runoff, although desirable, are not likely to significantly reduce metal loadings to the lakes.

Study results indicate that heavy metal loadings associated with urban runoff will increase from 10 to 20 percent in the Lake Michigan, Lake Huron, Lake Erie and Lake Ontario basins (without additional remedial programs to control urban runoff). While urban runoff controls result in comparatively small phosphorus load reductions, they appear to be effective in reducing metal inputs to the lakes. Remedial programs, such as frequent steeetsweeping, could be expected to reduce metals input by approximately 40 percent by the year 2000. Estimates indicate that more extensive control programs, such as streetsweeping in conjunction with detention and treatment of stormwaters and combined sewer overflows, result in a 60 percent reduction in metal loadings.

These studies emphasize the importance of evaluating remedial programs on a comprehensive basis. Management programs shown to be comparatively cost-effective in reducing phosphorus loading from land drainage may have little effect on the input of heavy metals to the lakes. Alternatively, measures which may result in significant reductions in metals loading may not be of critical importance, in view of the current lack of evidence that metal inputs are creating problems in the Great Lakes. Further, the high cost of urban runoff control must be considered in relation to the potential benefit from decreased metal inputs to the Great Lakes.

CHAPTER 4

SURVEY OF AGRICULTURAL RESEARCH ON THE CAUSES AND CONTROL OF NONPOINT SOURCE POLLUTION

A survey was conducted by the Basin Commission staff to summarize current research efforts on the causes and control of nonpoint source pollution.[1] The review focused on research activities being carried out at universities and research stations, primarily in the Great Lakes states.

Several sources were utilized to obtain information on ongoing research projects.[2] A retrieval made on WRE, the Water Resource Research data base of the Water Resource Scientific Information Center (part of the Office of Water Research and Technology, U.S. Department of Interior) accessed information from the Smithsonian Science Information Exchange. Another source of information was the "Catalog of Federal Ocean Pollution Research Development and Monitoring Programs, Fiscal Years 1978-1980". Studies funded by National Oceanic and Atmospheric Administration programs (Great Lakes Program, Sea Grant) and Environmental Protection Agency programs (Great Lakes Program, Great Lakes National Program) were reviewed for research involving nonpoint source pollution.

The greatest number of ongoing research projects were obtained from a retrieval made on the Current Research Information System (CRIS), maintained by the USDA Cooperative State Research Service. The search was limited to the eight basin states and uncovered a number of pertinent studies (roughly 400) sponsored or conducted by USDA research agencies, state agricultural experiment stations, state forestry schools, and other cooperating state institutions. Approximately 50 of the projects identified, dealing with phosphorus and sediment control, agricultural land use, and the economics of implementing pollution control measures, were singled out as being particularly relevant to Post-PLUARG interests. Descriptions of these research projects are contained in Appendix E. Detailed information was requested from the researchers involved in a number of these projects.

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[1] Atmospheric sources of pollution, with the exception of wind erosion, were not included in the subject matter. It was felt that this would involve a whole other realm of study.

[2] Projects active during the years 1979-1980 were included.

POLLUTION FROM AGRICULTURAL LAND USE

Agricultural land use is the major diffuse source contributor of phosphorus to each of the Great Lakes, with the exception of Lake Superior (PLUARG, 1978). Its significance is underscored by the proportionally large number of research projects involving agricultural sources of pollution.

Modeling activities underway include studies of the dynamics of water and pollutant movement in rural soils, estimation of the volume of runoff and sediment yield from small agricultural watersheds, and estimation of the magnitude of nitrogen and phosphorus in runoff from agricultural land. At Cornell University, modeling of phosphorus inputs to upper New York State's Finger Lakes is currently underway. Schaffner and Oglesby (1978) determined phosphorus loadings to the 13 lakes, based on a composite species of phosphorus and by expressing loadings as the amount added to the lake mixed zone. Further work by Oglesby and Schaffner (1978) examined lake response to mixed zone loading as an interrelated series of regression models. The use of simple components in the models, and the fact that the parameters (e.g., transparency) can be directly observed by the public, make this a potentially useful tool for developing strategies for water quality management.

Other agricultural studies are evaluating various management techniques' effects on water quality. These include: effects of removal of crop residues; tillage-mulch effects on erosion and infiltration; effectiveness of soil and water conservation practices for pollution control; effects of different feedlot waste management systems on water quality, soil loss and nutrient transport under various conditions; and the effects of different pasture and crop management systems on the levels of nutrients, pesticides, and sediments contributed from watersheds.

POLLUTION FROM FEEDLOTS

Several projects in the region are investigating the feasibility of using different management treatments to control the discharge of pollutants below active feedlots. Runoff from livestock feedlots has long been recognized as a potential source of pollution, and runoff catchment basins have been used as the best method of control. However, these basins are expensive and often require the purchase of additional equipment. Additionally, they can present odor problems if not maintained properly. The use of non-structural methods, especially vegetated buffer strips, has proven effective in reducing both nutrients and microorganisms in feedlot runoff (Thompson et al., 1978; Young et al., 1980). Previous work by Young and Holt (1977) and Young and Mutchler (1976) indicates that the practice of spreading manure on frozen soil or on top of snow may not be as hazardous as once thought, depending on the conditions under which it is applied (soil type, slope, plowed or unplowed land, cover type, etc.). However, there has been insufficient research on the extent to which winter spreading causes water pollution.

The use of buffer strips is considered by many 208 agencies to be one of the best available management practices for controlling pollution from livestock waste and agricultural runoff. However, the parameters for the design of buffer strips are generally unavailable. A study by Aull (1979) compares two types of buffer configurations. Cropland runoff is viewed on the scale of one farm or field, in which case runoff acts less like a nonpoint source and more like an intermittent point source. The use of a discrete vegetated buffer area, instead of a filter strip along the length of a watercourse, appears promising for reducing pollution loadings while at the same time occupying a smaller land area.

ECONOMICS OF CONTROLLING POLLUTION FROM AGRICULTURAL ACTIVITIES

One of PLUARG's recommendations under agricultural land use was that any water quality plans to be implemented by farmers must be "commensurate with the farmers' ability to sustain an economically viable operation." The economics of a number of agricultural source control methods are being investigated. Areas of research include: determination of economically efficient methods available to achieve alternate levels of pollution control; analysis of the effects of pesticide pollution abatement policies on production costs and food and fiber prices; evaluation of the cost-effectiveness of various control measures for nitrogen and phosphorus runoff; and investigation of alternative methods and rates of disposal of municipal and feedlot wastes on agricultural land (to determine the economic optimum waste disposal systems and rates of application for farmers and municipalities).

POLLUTION FROM SILVICULTURAL PRACTICES

Although not considered a significant contributor to nonpoint pollution of the Great Lakes, forestry operations can be a problem on a local scale. Good forest management and harvesting practices can greatly reduce the movement of fine-grained sediment and nutrients from land surfaces to Great Lakes surface waters (Corbett et al., 1978). Some of these practices include: strip cutting as opposed to large area clearcuts, with prompt revegetation of the cut strips; careful placement and management of logging roads; and retention of buffer strips along streams. Research is being conducted on the effects of different forest watershed management practices on water quality and yield at Penn State University and the University of Minnesota. Other studies are concerned with evaluating the economic impact of silvicultural practices and programs undertaken to control nonpoint sources of pollution.

RESEARCH NEEDS

Very little information is presently available relating the costs of various agricultural best management practices (BMPs) to the incremental water quality benefits obtained. Much of the funding for agricultural nonpoint source water pollution has been directed toward planning and demonstration projects. The net result has been the installation of BMPs of unknown benefit.

There has been a tendency to equate BMPs with soil and water conservation practices (SWCPs). These are incorporated in farm conservation plans, and have the significant advantage of an existing delivery system consisting of technical assistance, federal cost sharing, and local level management. It is assumed that, because SWCPs reduce the amount of eroded soil and runoff (the principal carriers of potential water pollutants), they therefore improve water quality. This hypothesis has not been well studied. While SWCPs may reduce some water pollutants, they may not be cost-effective mechanisms for nonpoint source control. Cultural measures, such as controlling the application of manure, fertilizer, and pesticides, may be more effective and efficient than control of runoff in some situations.

The Section 208 program and several large demonstration projects have illustrated that BMPs can be planned and that conservation programs can be implemented. However, the actual water quality benefits attributable to many of these best management practices, and the impact resulting from their installation, still remains largely unknown.

CHAPTER 5

UPDATE ON PLUARG FINDINGS AND RECOMMENDATIONS

The preceding chapters have summarized and provided updated information on a number of activities and programs concerned with the abatement of nonpoint source pollution. It is apparent that progress continues to be made in developing a technical and management base upon which to build an environmental management strategy for the Great Lakes system. This chapter will examine the relationship of the activities described earlier to the findings and recommendations made by PLUARG.

POLLUTION FROM LAND USE ACTIVITIES

PLUARG studies identified a number of diffuse source pollutants which were either a present or potential water quality problem. These substances included phosphorus, sediment, PCBs, organochlorine pesticides used in the past, industrial organic compounds, mercury, and, possibly, heavy metals. Microorganisms were considered a minor problem. Results made available from recently completed studies have not changed this finding.

Post-PLUARG tributary monitoring programs in Ohio and Wisconsin will soon generate additional information on pollutant loadings to the lakes. As previously mentioned, the Ohio program is already 50 percent complete. An important function of these sampling programs will be to provide additional information on the percentage of biologically available phosphorus associated with the tributary load. Recent evidence indicates that 40 to 50 percent or more of the total phosphorus contributed by Great Lakes tributaries is unavailable for plant growth (Sonzogni et al., 1980).

The Phosphorus Management Strategies Task Force (PMSTF) has highlighted the need for additional research on phosphorus availability. Of particular importance are studies which will identify sources of phosphorus in terms of their relative bioavailability. It is only with such information that those activities having the most substantial impact on Great Lakes water quality can be identified and targeted for diffuse source control. Such information is essential for development of a cost-effective pollution abatement strategy.

SOURCES OF DIFFUSE POLLUTANTS

A major conclusion of the PLUARG study was that land factors such as land form (e.g., soil texture and type, physiography, etc.), land use intensity and materials usage must be considered along with land use in determining the relative magnitude of pollution to be expected from any given area. Meteorological conditions also need to be considered in determining those portions of a watershed which are "hydrologically active". A great deal of attention is being focused on this set of factors affecting pollution from land.

The research survey highlighted a number of efforts underway in the basin which are addressing such things as the influence of soil type on pollutant loadings, mitigating effects of various crop cultivation practices, and the effects of silvicultural practices on water quality. Computer modeling to describe pollutant loading and transport and the effects of alternate management strategies is also receiving considerable attention.

Additional information from PLUARG's Menomonee and Maumee pilot watershed studies has contributed to our knowledge of fluvial transport mechanisms, the effectiveness of various BMPs in controlling erosion, and the effects of seasonal changes on nutrient and sediment loading. These studies have also underscored the importance of considering soil characteristics when evaluating the diffuse source contribution to be expected from any given area.

Results obtained from the technical studies conducted under the Washington County 108(a) Demonstration Project generally supported and reinforced the conclusions of PLUARG (i.e., significance of construction activities in urbanizing areas). It will be important to integrate study results concerning the feasibility and acceptability of, and water quality improvements associated with, conservation tillage practices with those of the Honey Creek study and the Saginaw Bay ACP Special Project as more information becomes available. Results obtained from the Honey Creek water quality monitoring activity will be of special interest in light of the Demonstration Project's finding that the highest available phosphorus losses were associated with the no-till sites.

PLUARG concluded that streambank erosion was not a major pollutant source to the lakes, accounting for only about 7 percent of the estimated total tributary load. Initial results from the Cuyahoga River Restoration Study support this finding, albeit on a localized level. It will be important to monitor future efforts conducted under this study and an additional study proposed by the Corps of Engineers to reduce sediment transport to the Lorraine Harbor. The study would focus on Ohio's Black River, closely paralleling work conducted under the Cuyahoga River Study.

MANAGEMENT STRATEGY

Progress continues to be made toward development of a Great Lakes environmental management strategy. The IJC has completed its review of PLUARG's recommendations and will soon be transmitting its comments to governments. The PMSTF will be completing its work within the next few months. Establishment of final target loads, coupled with the IJC recommendations, should provide a strong framework for development of a management strategy.

As previously discussed, future funding under the 208 program will be primarily directed toward prototype projects for control of nonpoint source pollution. The study conducted by Heidtke et al. (1979b) utilizing the overview modeling process, found that mechanisms to control urban runoff were not cost-effective in terms of the reduction achieved in the annual total phosphorus load to the Great Lakes, but may significantly reduce heavy metal loadings. The capability of urban controls for reducing heavy metal inputs must be further evaluated from the standpoint of cost and the potential benefits to be derived from decreased metal inputs. There is still insufficient evidence that metal inputs are creating problems in the lakes. Results of the Nationwide Urban Runoff Program should provide needed information on the benefits and cost-effectiveness of urban controls. With this additional information, the need for further controls beyond those recommended by PLUARG can be ascertained.

As 208 monies are directed away from point source control and general planning activities, state and local governments should be encouraged to provide additional funding to maintain the regional water quality management programs. This will help ensure that the solutions to water quality problems developed in the management plans are implemented by the network of local designated management agencies. A continuing planning process is necessary to address new water quality problems as they arise.

State and regional five year strategies recommended only a small number of programs specific to the Great Lakes. However, a number of studies were identified which are of particular relevance to Great Lakes concerns and which would address water quality problems utilizing a systems approach (e.g., studies of atmospheric sources of pollutants). A number of these studies will likely receive low priority for 208 funding in the immediate future. Funding from alternate sources should be encouraged.

PLUARG concluded that "atmospheric loads are a significant source of many pollutants to the Great Lakes and constitute a potentially controllable source." It is, therefore, important that additional efforts be made by U.S. EPA and the states to coordinate air and water quality planning and management programs. Inclusion of air pollution control programs in some state-EPA agreements and state and regional five year strategies is an important first step in achieving this. Additional efforts are also needed to expand international cooperation in the area of air pollution control.

A number of financial assistance programs are now available to provide funds for the implementation of nonpoint source remedial measures. These include the Rural Clean Water Program and the Agricultural Conservation Program on a national level, and the Wisconsin Nonpoint Source Water Pollution Abatement Program on a regional level. Projects such as the Washington County Demonstration Project and the Lake Erie Wastewater Management Study have provided considerable technical information on BMPs and developed model management programs. The Washington Project went on to explore local legal and institutional arrangements for effecting nonpoint source control and public relations programs. PLUARG recognized both of these as essential activities.

Proposed objectives and activities under the new Soil and Water Reosurces Conservation Program are consistant with a number of PLUARG's recommendations, as previously discussed. This developing program will provide an additional framework within which to develop components of a management strategy.

PLUARG included wetland preservation in its recommendations for development of an environmental management strategy. An important development in this area occurred in January of this year when the Michigan Wetland Protection Act (Act No. 203) was signed into law. The State Department of Natural Resources, working with the U.S. Fish and Wildlife Service, is proceeding with an inventory of wetland areas. It is expected that, by the end of 1980, 60 percent of the state will be completed. Prompt completion of the inventory is imperative in counties of 100,000 people or less. Inland wetlands in these areas are generally not subject to the requirements of the Act prior to completion of the inventory.

The following recommendations were recently included in the Great Lakes Basin Plan's water quality element. They effectively summarize areas where emphasis should be directed in the coming months in light of information currently available.

1. Rapid implementation of the 1 mg/L phosphorus limitation (for sewage treatment plants 1 mgd or greater) should be encouraged. Further evaluation of more stringent control options should continue to be evaluated via research and demonstration projects.

2. Nonpoint source control programs which emphasize minimal costs should be implemented immediately.

3. Additional study of the significance of atmospheric inputs of toxics is necessary.

4. Additional resources should be provided to state and regional water quality planning agencies to assist them in participating more fully in Great Lakes planning.

5. Major resource planning and management programs (such as those under the Clean Air and Water Acts) should be integrated.

6. Remedial programs should be evaluated on a comprehensive basis to fairly compare their overall cost-effectiveness (e.g., urban runoff controls to reduce phosphorus or metals loadings).

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APPENDIX A

LAKE ERIE WASTEWATER MANAGEMENT STUDY:
HONEY CREEK WATERSHED MANAGEMENT PROJECT

The following is an informal GLBC staff summary of the Honey Creek Watershed Management Seminar/Tour held in Bucyrus, Ohio, on October 22nd and 23rd, 1979. Data and information were presented on the initial results from several farms in the area that had used the no-till or mulch-till approach to farming. A complete list of attendees is attached.

INTRODUCTION

As part of the U.S. Army Corps of Engineers' Lake Erie Wastewater Management Study, funds were made available to examine the feasibility of reducing pollution runoff from agricultural land. To evaluate various farming practices and their impact upon water quality as well as the economics of farming, a joint board of supervisors was formed representing the Soil and Water Conservation Districts of three counties in Ohio. These counties contain a 187-square-mile watershed called Honey Creek, tributary to the Sandusky River. The Corps of Engineers helped finance farmers to plant crops using conventional tillage, mulch-till and no-till procedures in the spring of 1979.

MULCH-TILL

The term "mulch-till" is used to describe the practice of maintaining a ground cover over a field as long as possible over the year. If a mulch is present, it will protect the ground from raindrop impact and soil movement during heavy rainfalls. There is no other significant difference between mulch-till and conventional-till in terms of farming practices, machinery needed or, apparently, costs (although only one farm reported costs for mulch-till). There will still be times when the entire field will be plowed and produce significant pollution runoff.

NO-TILL

No-till farming differs significantly from conventional tillage. A comparison of the two practices shows that expenditures for seed, lime, and miscellaneous overhead are roughly the same, along with dollars outlaid for various fertilizers. The no-till approach requires several different chemicals, such as a herbicide designed to burn off the ground cover at the time of planting. There is no appreciable difference in insecticide expenditures. The machinery requirements, and thus capital outlay, interest payment, and depreciation, vary significantly. The no-till approach requires planter equipment, spray equipment, and harvesting equipment, while the conventional-till requires a plow, tandem disc, harogator, planter, spray, cultivator, and harvesting equipment. Conventional-till also requires a much larger tractor to pull the plows.

The cost per acre for conventional-till ranges from \$201/acre to \$224/acre, and for no-till, from \$183 to \$209/acre (see attachments). Depending upon the chemicals required or chemical availability, the no-till operation is almost always less than the conventional-till approach in terms of cost per acre (data were obtained from three test farms and presented at the seminar). Two figures that were not presented, but came out in discussion, were the amount of time required to perform the two operations and the fuel consumption difference between the two procedures. One farmer reported that it took him six hours and 20 minutes (not including harvesting) for a 15-acre plot in no-till, and 34 hours for the same size plot in conventional-till. The no-till accomplished about the same yield (harvesting had not yet occurred, although standing crops looked very similar for both practices) for just under 20 percent of the time needed to perform conventional-till operations. For 15 acres of no-till planting, 15 gallons of fuel oil were needed. For 15 acres of conventional planting, 99 gallons of fuel oil were needed. This was primarily due to the number of extra passes the tractor must make and the horsepower required to pull a conventional plow through the soil.

The no-till planter performs several operations in one. It has a disc or chisel device that separates a ridge down the field approximately two to three inches wide and several inches deep. This disc is then followed by fertilizer, seed application, and usually a herbicide to burn off the cover that may be competing with the new seedlings (cover is replanted in the fall). No other soil is disturbed other than the small opening needed to plant the seed. The burned cover acts as a mulch over the summer. Conventional operations turn over all of the soil to much greater depths, and pass with discs and harogators to smooth out the soil before the planter inserts seed.

An interesting fact was brought up concerning the planters. Some of the farmers in the area have a planter that could now be used for the no-till operation. Some equipment manufacturers have begun to make no-till planters available by modifying existing planters. A no-till planter can be used in both no-till and conventional-till practices, while the conventional planter can only be used under conventional settings. As a result, to gain flexibility for future development, a number of farmers have bought a no-till planter, although they had not used it in no-till before.

Because of the large difference in equipment requirements, both in size and in number of pieces, equipment manufacturers have been somewhat reluctant to promote this form of farming. A no-till farmer would no longer need a huge $80,000 four-wheel-drive tractor to perform his plowing operation; nor would he need a number of the additional implements that are used for grooming the fields. On the other hand, chemical manufacturers and fertilizer producers have been most helpful in developing no-till farming. More chemicals are required to promote the no-till approach.

It is possible that no-till farming could be promoted on energy and time savings. With the tremendous rise in fuel oil and gasoline prices, a considerable savings can be realized using lighter tractors and fewer runs across a field. As mentioned earlier, an 85 percent fuel savings was realized between two test plots. Additionally, because of the tremendous time savings, a farmer can have time to crop more land or to diversify into livestock or other farm-related business.

The farmers who participated in the program were very optimistic and encouraged about the no-till approach. A number of their neighbors were somewhat skeptical. It was interesting to note that, as the crop came up and the time and money savings were documented, a number of the neighboring farmers were won over to the program and are interested in participating next year. A program such as this may significantly improve water quality without issuance of stringent water quality regulations or laws designed to direct farming activities because of the economic benefits that a farmer can grasp.

Productivity tests had not yet been completed at the time of the tour. However, it appeared that crop emergence and the health of the crop was virtually identical between the conventional field and the no-till field.

IMPLICATIONS FOR WATER QUALITY

Heidelberg College (Tiffin, Ohio), along with the Corps of Engineers, has set up sampling stations in Honey Creek watershed. They will be attempting to document change over years in sediment, phosphorus, and other parameter concentrations and loads due to no-till approaches. Because of limited funding, they were not able to significantly sample conventional fields before they went to no-till. Because of the wide fluctuations in rainfall, the loading data have been extremely erratic and do not allow for an interpretation of the effect of no-till farming. Some general observations were offered. From May through October, 1979, a record 32 inches of rainfall fell on the Honey Creek watershed. A survey of two fields side by side -- one no-till, one conventional-till -- showed that significant soil movement and loss occurred in the conventional-till field relative to the no-till. This is particularly noticeable on sloping fields in the area.

It may be difficult to produce numbers for some time on the improvement in water quality due to no-till farming. The participants in this program feel very strongly that more time and much more money should be put into this project or similar projects to do a proper analysis of the effects of no-till farming on water quality and on the long-term effects on soil.

The biggest questions facing farmers at this time are:

- What will happen to the soil after 10 or 20 years of no-till?
- What will happen after repeated herbicide applications?
- How will the soil behave without being turned over after a long time?
- What will cover crops do to the soil over time?

These and other questions can only be answered by future research.

HONEY CREEK WATERSHED MANAGEMENT PROJECT

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STOP #1
Honey Creek Seminar-Tour
October 22, 23, 1979

Bill Smith (no-till)

Seed, lime, misc.		$40.00
Fertilizer:	30-18-13 (blend)	66.00
	9-27-3+2	9.36
Chemicals:	1 qt. Paraquat 2 CL	10.00
	X-77 Spreader 302/ac	.30
	1-5 qt. Aatrex 4L	4.31
	2-5 qt. Bladex 4L	8.16
Insecticide:	Diazinon ssed treater	.50
	15# Furadon 106	11.25
TOTAL VARIABLE COSTS		$149.88

Machinery (custom rates)		
	Plant	10.00
	Harvest	18.00
	Spray 1	3.00
	Spread fertilizer 1	2.50
TOTAL MACHINERY		$33.50
TOTAL COSTS		$183.38

Time:
1 hr. 40 min. fertilize
3 hr. 40 min. plant
1 hr. 00 min. spray
TOTAL
6 hr. 20 min. for 15 ac.
15 gal fuel for 15 ac.

Bill Smith (conventional)

Seed, lime, misc.		$40.00
Fertilizer:	Broad same	66.00
	Starter same	9.36
Chemicals:	3.3 pt Dual 6E	10.93
	2.5 qt. Bladex 4L	8.16
Insecticide:	Diazinon seed tre.	.50
	10# Furadon 106 w/plane	11.00
TOTAL VARIABLE COSTS		$145.95

Machinery (custom rates)		
	Plant	7.00
	Harvest	18.00
	Spray 1	3.00
	Spread fertilizer 1	2.50
	Plow	10.00
	Hardgator w/packer	4.50
	Disc w/packer	4.00
	Rotary hoe	2.50
	Cultivate	4.00
TOTAL MACHINERY		$55.50
TOTAL COSTS		$201.45

Time:
32 hr. 00 min. plow, till, plant, etc.
2 hr. 00 min. spray Furadan
TOTAL
34 hours for 15 ac.
99 gal fuel 15 ac.

Conventional	$201.45
No-till	-183.38
Savings	$ 18.07

PAUL PRICE
TILLAGE SYSTEMS ECONOMIC COMPARISONS

Expense Items	---------Per Acre Costs--------- No Till	Mulch Till	Convent. Till
Seed, Lime, Misc.:			
(Soil Test, Phones,etc.)	40.00		40.00
Fertilizer:			
N P IL 223 196 139			
Start 240# 9 - 27 - 3+2^{s}	21.60		21.60
Broadcast 600# 7 - 26 - 26	48.00		48.00
W/ Herb. (53gal.) 28 - 0 - 0	31.42		31.42
Sub Total:	101.02		101.02
Chemicals:			
2 qt. Roundup 4 EC	29.00[1/]		——
2 qt. Bladex 4L	7.50		7.50
2 qt. Attrex 4L	6.50		6.50
Insecticides:			
Isotox "F" Seed Treater	1.25		1.25
14# Furadan 10E	11.20		11.20
	12.45		12.45
Total Variable Costs:	196.47		167.47
Machinery (Custom Rates):			
Plow	——		10.00
Tandem Disk	——		4.00
Harogator	——		9.00
Plant	10.00		7.00
Spray, Spread Fert.	8.00		5.00
Cultivate	——		3.50
Harvest	18.00		18.00
	36.00		56.50
Total:	$232.47		$223.97

Conv.	223.97		223.97
No-Till (w/ Roundup)	- 232.47	N.T. w/ Paraquat	- 209.47
	+ 8.50 > Conv.		14.50 < Con

[1/] - Roundup used to control quackgrass. Would normally use 1 qt. of Paraquat instead. (Paraquat costs normally $6.00, this would be $23.00 less.)

[2/] - Using No Till with paraquat instead of Roundup would be $14.50 cheaper than conventional.

DON PHENICIE

TILLAGE SYSTEMS ECONOMIC COMPARISONS

	------ Per Acre Costs ------		
Expense Items	No Till	Mulch Till	Convent. Till
Seed, Lime, Misc. (soil test, phones, etc.)	4000	4000	4000
Fertilizer:			
Broadcast < 200# 0-44-0 300# 0-0-60	3200		
Starter 225# 14-21-9	15.75		
w/Herb. (65gal.) 28-0-0	39.27		
	87.02	87.02	87.02
Chemicals:			
2 qt. Roundup 4 EC*	29.00[1]	(1pt.Para) 6.00	—
2.5 qt. Bladex 4L	8.13	(3.3pt.Dual) 10.93	(2qt.) 8.13
2 qt. Attrex 4L	5.50	5.50	5.50
Post Apply - 8oz.-Banvel	4.16	—	4.16
	46.79	22.43	17.79
Insecticides:			
Diazinon	1.25	1.25	1.25
14# Furadan	11.20	11.20	11.20
4# Sevin	—	(4#Sevin) 5.40	—
Total Variable Costs:	186.26	167.30	157.00
Machinery (Custom Rates):			
Plow	—	—	10.00
Tandem Disk	—	(1-Fall) 4.00	(2) 8.00
Cultimulcher	—	—	4.00
Plant	10.00	10.00	7.00
Spray, Spread Fert.	11.00	8.00	8.00
Cultivate	—	—	3.50
Harvest	18.00	18.00	18.00
	39.00	40.00	58.50
Total Costs	$225.26	$207.30	$215.76

[1] - Roundup used to control Quackgrass - normally use 1 qt. Paraquat

Conv. 215.76 215.76 215.76
N.T. w/Para. 207.26 N.T. w/ Roundup 225.26 M.T. w/Para 207.30
8.50<Conv. 9.50>Conv. 8.46<Cc

Conv. 215.76 215.76

N.T. w/ Roundup 225.26 9.50>Conv. M.T. w/ Para 207.30 8.46<Conv.

APPENDIX B

SECTION 108(a) DEMONSTRATION PROJECTS: THE WASHINGTON COUNTY, WISCONSIN, PROJECT

Washington County is located in southeastern Wisconsin, just northwest of Milwaukee. Farmland currently accounts for 60 percent of the land area, but is under intense urbanizing pressure from the nearby metropolitan area. Washington County was selected as an excellent location for developing rural and urban sediment control programs transferrable to similar developing areas in the basin.

The project was composed of three ongoing studies: legal and institutional arrangements, technical study, and development of an education and information program. Summaries of their final reports are presented below.

LEGAL AND INSTITUTIONAL UNIT

The goal of this unit was to design and implement programs to control pollution caused by sedimentation. The project was designed to determine whether local governments would be likely to enact and implement sediment control programs given both technical and financial support. The effectiveness of such programs was also studied.

Programs were designed to control the two major sources of sediment in the county: construction site erosion and erosion from cropland. Their development followed these general guidelines:

1. Programs must be developed with the advice and consent of local officials who would eventually be responsible for their implementation.
2. Ordinances should be easy to understand and administer.
3. Regulation should only be imposed to control excessive sedimentation.

4. Programs should be developed which could readily be adopted by local governments lacking the financial and technical support which makes this project unique.

5. Programs must be within the scope of existing enabling legislation.

Project personnel reviewed local sediment control and zoning ordinances and recommended modifications. New ordinances were also drafted. Their effort was only partially successful. For example, the county board enacted a construction site erosion control ordinance, but was unwilling to proceed with an ordinance for rural erosion control. The experience suggests that local governments will enact sediment control regulations only in limited circumstances.

The construction site ordinance required little additional administrative expense, added a small cost to developers and home buyers, and would have successfuly controlled erosion. Conversely, the rural ordinance was perceived as imposing an additional cost on the county as well as on some farmers, requiring them to operate at a competitive disadvantage with farmers from other parts of the state. Local officials did not perceive a benefit to match this extra cost. Researchers felt that this experience indicated the need for minimum statewide standards to regulate erosion from farmland.

The researchers also investigated the roles of the various agencies with responsibility for programs dealing with sediment control. To effectively coordinate programs in the county, the authority for and resources available to the agenices needed to be defined and, in some instances, new interagency relationships designed. A common situation emerged. Although several agencies were involved in programs clearly related to sediment control, the goal of improvement of water quality was not actively pursued. State and federal agencies generally held responsibility for water quality protection, with responsibility for land use control held at the local level. The researchers emphasized that, in the future, effective sediment control programs for improvement of water quality will require that these separate functions be united in some manner.

At the conclusion of their review, project personnel were able to develop an institutional arrangement considered to be the most desirable for achieving sediment control goals. The following requirements were viewed as necessary for effective administration of a sediment control program:

1. Recognition that local personnel, familiar with local social and physical conditions, are the key to the success of either a voluntary or a regulatory program. Funding for local technical and administrative personnel should receive high priority.

2. The state should provide financial assistance to local agencies for the manpower necessary to implement their program.

3. Training programs are necessary for local agency personnel unfamiliar with methods for controlling sediment pollution problems.

4. Ongoing conservation programs should be instigated statewide. Short-term programs to control pollution in priority areas are not the final solution to a long-term problem.

5. Local personnel must be sensitive to the concerns of the farmer and developer if they hope to convince them to adopt alternative management practices.

Consistent with PLUARG's recommendations, the researchers advocated focusing institutional resources on "critical areas" first. In this manner, the maximum improvement in water quality will be obtained for each investment dollar. Land use and water quality data, as well as public input, were recognized as essential information for identifying "critical areas".

TECHNICAL UNIT

The primary goal of this portion of the study was "to demonstrate the relationship of certain land uses to water pollution and - in specific areas - to determine the effectiveness of several sediment and erosion control techniques for improving water quality." Major objectives were as follows:

1. "To measure the amount of water and the concentrations of sediment and associated pollutants in surface runoff from agricultural and urbanizing areas, and to compute pollutant loadings.
2. To identify those characteristics of different land uses and management practices that contribute to sediment-related water pollution problems.
3. To investigate the effectiveness of erosion control measures in reducing runoff and pollutant discharges from specific agricultural sources -- particularly cropped fields and barnyards -- by using a "before and after" treatment approach.
4. To examine methods for reducing soil erosion and sedimentation from housing construction in a residential subdivision."

The researchers collected and analyzed data for two years from eight monitoring stations established in the agricultural and developing residential watersheds in Washington County. Relationships between precipitation, runoff, land use and water quality were studied. A series of farm best management practices were implemented and their effectiveness and acceptability evaluated. Methods of erosion control at construction sites were also evaluated. Study findings included the following:

1. "Well-managed croplands on dairy farms showed relatively low losses. Contour strip-cropping proved to be a highly effective sediment and nutrient control practice on steep-sloped croplands. The water quality benefits of grass waterways and subsurface drainage systems in relatively flat watersheds, however, were questionable."

   (This conclusion differs from studies in the Maumee basin in northwestern Ohio, where these measures on flat watersheds were judged to be benefical to water quality.)

2. "Unmanaged barnyards were the largest contributors of pollutant loads in the dairy farming watersheds. The experimental management system installed in one watershed demonstrated that effective management is possible.

3. Sediment carried most of the phosphorus and nitrogen measured in runoff from rural and urbanizing sites. However, land management practices could successfully reduce loads of sediment and their associated pollutants, although dissolved loads were often increased.

4. Excessive sedimentation and other water quality problems associated with intensive housing construction were documented. Pollutant concentrations and loads diminished as the monitored subdivisions stabilized. Erosion control alternatives were identified but the effectiveness of the control measures were not successfully demonstrated during the most critical phases of development.

5. The feasibility and acceptability of conservation tillage practices were evaluated in detail. "No-tillage" has been poorly received in Wisconsin. On research plots in Washington County, technical limitations were observed with the "no-tillage" system. Other reduced tillage

systems, in particular chisel-plow systems, showed greater promise. Water quality improvements are possible but dependent on how the previous year's residue was managed. Yield reductions were small, and most importantly, farmers expressed more interest in these systems because of their labor and soil saving features.

6. Models and predictive methods addressing many agricultural aspects of sediment and related water quality problems were developed and applied. These included: (a) a series of computer programs to predict watershed sediment yield using the USLE; (b) an optimization model that predicts farm-level impacts of alternative sediment control policies; (c) a hydrologic model for predicting watershed soil losses on an event basis; (d) a multiple-regression model for predicting annual soluble phosphorus losses from cropped fields; and (e) a methodology for predicting total phosphorus losses from confined livestock and winter-spread manure."

The study of conservation tillage systems is particularly interesting in light of current work in the Honey Creek watershed under LEWMS. The systems evaluated in the Washington County Project were: conventional tillage (moldboard plowed and disked prior to planting), chisel plow (soil chisel plowed only prior to planting), and no-till (no tillage operations prior to planting). Effects of applying manure prior to tillage operations were also studied with reference to sediment and nutrient losses.

Results indicated that the manured, no-till plots had the lowest sediment and total phosphorus losses. However, a significant finding was that the highest available phosphorus losses were from the no-till sites. Grain yields at no-till sites were significantly lower; however, it was not determined whether the difference in yield was due to the effect of tillage on yield or an effect on population. In contrast, preliminary findings at Honey Creek indicate more favorable yields from no-till operations.

Large or consistent differences were not observed in runoff, sediment or phosphorus losses between the chisel and conventional plow methods. However, it was noted that several factors may have masked differences which would ordinarily have occurred. Chisel plowed sites were found to have somewhat lesser crop yields than conventionally tilled sites.

A survey was conducted of 50 farmers who had participated in a cost-sharing program for conservation tillage in Dane County, Wisconsin. The purpose of the survey was to assess farmers' experiences with and attitudes toward conservation tillage systems. Results indicated that farmers were generally pleased with conservation tillage, but somewhat dissatisfied with the no-till method. Most farmers did not experience significant yield reductions from conservation tillage as compared to conventional tillage. Forty percent of those surveyed experienced a significant yield reduction with no-till (however, this may have been attributable to severe drought conditions). Generally, the farmers felt that conservation tillage saved time and soil. Forty percent felt there was no financial saving over conventional tillage. It was noted that an average reduction of only one tillage operation (compared to conventional tillage) was achieved with the conservation methods employed by those interviewed. Further reduction is possible and would result in larger time, soil, and money savings.

EDUCATION AND INFORMATION PROGRAM

The goal of this phase of the Washington County Project was "to have a diverse group of target audiences made aware of the magnitude of and alternative solutions to the sediment problem in rural and urbanizing areas." The program was divided into informational and interactional activities. Informational strategies included the publication of brochures describing nonpoint source problems and the project in general; displays for state and county fairs; a slide program and short film; press releases, etc. Interactional activities included numerous presentations before various community groups, public participation meetings, workshops, etc. Results of the educational and information program were generally very satisfactory.

APPENDIX C

GLBC 208 BIBLIOGRAPHY RETRIEVAL

The following is a sample of a retrieval made from the GLBC "208" Bibliography discussed in Chapter IV. As previously mentioned, only a very limited number of entries have been made into the system thus far. The keywords chosen for this example were nonpoint sources: "remedial measures" (key word #220), "unit area loads/models" (key word #240) and "costs" (key word #260). The search included reports from every 208 agency for which information has been entered. The format selected for this sample retrieval included specification of the 208 agency acronym, state of location, applicable lake basin(s) and the title and date of the report.

****

STATE: Minnesota
LAKE(S): Superior
208 AGENCY: MPCA

Forestry. Package 1. August, 1979.

STATE: Minnesota
LAKE(S): Superior
208 AGENCY: MPCA

Preliminary Identification of Literature Models and Data for Evaluating Rural Nonpoint Nutrient, Sediment and Pathogen Sources. May, 1977.

STATE: Minnesota
LAKE(S): Superior
208 AGENCY: MPCA

Construction Activities. Package 1. August, 1978.

STATE: Minnesota
LAKE(S): Superior
208 AGENCY: MPCA

Highway De-Icing Chemicals. Package 1, Supplement. June, 1978.

STATE: Minnesota
LAKE(S): Superior
208 AGENCY: MPCA

Highway De-Icing Chemicals. Package 2. May, 1978.

STATE: Minnesota
LAKE(S): Superior
208 AGENCY: MPCA

Roadside Erosion. Package 2, Supplement to: Description of Existing Institutions and Programs Related to Water Quality Management Planning Study Topics. January, 1979.

STATE: Wisconsin
LAKE(S): Michigan
208 AGENCY: WDNR

Upper Fox River Basin Water Quality Management Plan. Appendix D: Nonpoint Source Information. 1977.

STATE: Wisconsin
LAKE(S): Michigan
208 AGENCY: FVWQPA

Report No. 5: Instream Alteration Study. October, 1977.

STATE: Wisconsin
LAKE(S): Michigan
208 AGENCY: SEWRPC

Technical Report No. 18: State of the Art of Water Pollution Control in Southeastern Wisconsin. Volume 4: Rural Stormwater Runoff. December, 1976.

STATE: Illinois
LAKE(S): Michigan
208 AGENCY: NIPC

Areawide Water Quality Management Plan Part I Chapters 1-10. June, 1978.

STATE: Illinois
LAKE(S): Michigan
208 AGENCY: NIPC

Areawide Water Quality Management Plan, Summary. (Adopted by Northeastern Illinois Planning Commission, January 4, 1979). March, 1979.

STATE: Indiana
LAKE(S): Michigan
208 AGENCY: MACOG

Plate Book. 1978.

STATE: Michigan
LAKE(S): Huron
208 AGENCY: ECMPDR

Development of Management Alternatives: Control of Pollution from Individual Waste Treatment Systems (Preliminary Draft). July, 1977.

STATE: Michigan
LAKE(S): Huron
208 AGENCY: ECMPDR

Alternative Structural and Non-Structural Tactics (Preliminary Draft). Region VII Areawide Waste Treatment Management Study. September, 1977.

STATE: Michigan
LAKE(S): Huron
208 AGENCY: ECMPDR

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STATE: Michigan
LAKE(S): Huron Erie
208 AGENCY: GLS-V

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STATE: Michigan
LAKE(S): Huron Erie
208 AGENCY: GLS-V

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STATE: Michigan
LAKE(S): Huron Erie
208 AGENCY: GLS-V

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STATE: Michigan
LAKE(S): Huron Erie
208 AGENCY: GLS-V

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STATE: Michigan
LAKE(S): Huron Erie
208 AGENCY: GLS-V

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STATE: Michigan
LAKE(S): Huron
208 AGENCY: NEMCOG

Appendices 1-9: Working Papers of the Clean Water Program. 1978.

STATE: Michigan
LAKE(S): Michigan Huron
208 AGENCY: NMRPDC

Working Papers.

STATE: Michigan
LAKE(S): Michigan Huron
208 AGENCY: Reg II

Selected 208 Plan. December, 1977 (Revised, April, 1978).

STATE: Michigan
LAKE(S): Michigan Erie
208 AGENCY: Reg II

Nonpoint Source Inventory (Draft). March, 1977.

STATE: Michigan
LAKE(S): Michigan Erie
208 AGENCY: Reg II

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APPENDIX D

1977-1978 RIVER MOUTH LOADINGS

The following are the results of the loading calculations described in Chapter 3. Information given is for water years 1977 and 1978. As previously mentioned, a more detailed analysis of these loads will be conducted under the next portion of the Post-PLUARG Agreement. Information is presented by tributary and the associated lake basin and river group (as explained in Chapter 3). The load is presented in metric tons per year (mt/yr) followed by the mean square error (in mt/yr) squared. Finally, the number of samples utilized to calculate the load is specified.

TOTAL PHOSPHORUS 1977

1 2	TRIBUTARY NAME	LAKE BASIN	RIVER GROUP	LOAD MT\YR	MEAN SQUARE ERR(MT\YR)**2	NUM OF SAMPLES
1	ST LOUIS	SUPE	1	70.3	44.0	13
2	BOIS BRULE	SUPE	1	9.5	8.7	9
3	NEMADJI	SUPE	1	37.2	80.4	23
4	BAD	SUPE	1	52.9	308.2	23
5	NEMADJI	SUPE	1	37.2	88.0	22
6	MONTREAL	SUPE	1	34.9	23.0	12
7	TAHQUAMENON	SUPE	2	21.2	10.2	24
8	PRESQUE ISLE	SUPE	2	5.9	1.6	12
9	STURGEON	SUPE	2	37.3	318.0	12
10	CARP	SUPE	2	21.1	20.4	8
11	ONTONAGAN	SUPE	2	141.1	2667.5	24
12	FORD	MICH	1	7.5	2.0	24
13	OCONTO	MICH	1	45.6	196.8	11
14	SHEBOYGAN	MICH	1	33.4	7.4	11
15	PESHTIGO	MICH	1	20.8	3.0	11
16	FOX	MICH	1	356.0	1708.0	25
17	PENSAUKEE	MICH	1	1.8	0.0	11
18	MANITOWOC	MICH	1	18.4	8.6	11
19	KEWAUNEE	MICH	1	4.7	0.1	10
20	E TWIN	MICH	1	18.0	1.0	11
21	SHEBOYGAN	MICH	1	335.7	7.4	11
22	ROOT	MICH	1	17.6	14.0	10
23	MENOMINEE	MICH	1	50.6	79.6	12
24	MILWAUKEE	MICH	2	38.4	31.2	12
25	ST JOSEPH	MICH	3	305.1	716.2	12
26	KALAMAZOO	MICH	3	173.8	136.6	24
27	GRAND	MICH	3	513.3	1094.2	242
28	MUSKEGON	MICH	4	38.4	18.9	24
29	MANISTEE	MICH	4	50.4	30.8	24
30	BOARDMAN	MICH	4	4.0	0.4	12
31	*MANISTIQUE	MICH	4	39.5	12.8	24
32	WHITEFISH	MICH	4	4.4	1.2	12
33	ESCANABA	MICH	4	33.0	24.9	24
34	THUNDER BAY	HURO	1	10.8	1.1	12
35	RIFLE	HURO	1	13.2	16.9	24
36	AU GRES	HURO	1	1.9	0.1	12
37	CHEBOYGAN	HURO	1	18.0	9.2	24
38	AU SABLE	HURO	1	14.5	4.4	12
39	PINE	HURO	1	84.9	1779.1	12
40	SAGINAW	HURO	2	510.6	2282.4	36
41	GENESEE	ONTA	1	298.9	2233.0	17
42	OSWEGO	ONTA	2	799.4	71146.0	22
43	BLACK NY	ONTA	3	146.0	167.7	21
44	RAQUETTE	ONTA	3	91.1	435.0	8
45	GRASS	ONTA	3	78.1	129.2	8
46	OSWEGATCHIE	ONTA	3	69.0	260.8	8

TOTAL PHOSPHORUS 1978

1	TRIBUTARY	LAKE	RIVER	LOAD	MEAN SQUARE	NUM OF
2	NAME	BASIN	GROUP	MT\YR	ERR(MT\YR)**2	SAMPLES
1	ST LOUIS	SUPE	1	307.2	9983.4	8
2	NEMADJI	SUPE	1	86.8	274.0	24
3	BOIS BRULE	SUPE	1	9.8	19.5	7
4	MONTREAL	SUPE	1	13.7	2.5	12
5	BAD	SUPE	1	54.9	49.1	12
6	OCONTO	SUPE	1	42.0	46.2	14
7	PRESQUE ISLE	SUPE	2	6.4	0.2	11
8	STURGEON	SUPE	2	29.4	71.1	11
9	TAHQUAMENON	SUPE	2	24.5	8.4	24
10	ONTONAGON	SUPE	2	119.0	1060.5	23
11	FORD	MICH	1	10.6	2.4	24
12	MENOMINEE	MICH	1	102.6	216.9	12
13	PESHTIGO	MICH	1	27.2	8.0	4
14	PENSAUKEE	MICH	1	5.3	0.4	12
15	KEWAUNEE	MICH	1	22.1	55.2	27
16	E. TWIN	MICH	1	12.9	1.5	12
17	MANITOWOC	MICH	1	86.0	685.9	12
18	SHEBOYGAN	MICH	1	93.0	576.3	12
19	ROOT	MICH	1	50.3	251.6	12
20	FOX	MICH	1	779.9	5948.4	24
21	MILWAUKEE	MICH	2	97.4	99.0	12
22	ST JOSEPH	MICH	3	296.2	1504.2	12
23	KALAMAZOO	MICH	3	200.0	150.6	24
24	GRAND	MICH	3	478.9	2891.8	22
25	MUSKEGON	MICH	4	33.7	43.0	24
26	BOARDMAN	MICH	4	3.4	0.1	12
27	WHITEFISH	MICH	4	6.4	2.6	12
28	MANISITEE	MICH	4	60.5	81.4	24
29	*MANISTIQUE	MICH	4	52.5	26.0	24
30	ESCANABA	MICH	4	38.3	49.8	24
31	THUNDER BAY	HURO	1	10.8	1.3	12
32	AU GRES	HURO	1	7.1	1.3	12
33	AU SABLE	HURO	1	22.4	3.6	12
34	PINE	HURO	1	72.0	1689.5	12
35	RIFLE	HURO	1	15.8	12.0	23
36	CHEBOYGAN	HURO	1	30.5	163.2	23
37	SAGINAW	HURO	2	602.3	7070.2	35
38	GENESEE	ONTA	1	481.8	3845.9	8
39	OSWEGO	ONTA	2	605.2	1746.1	11
40	BLACK NY	ONTA	3	113.9	397.4	11

SOLUBLE ORTHO PHOSPHORUS 1977

1	TRIBUTARY	LAKE	RIVER	LOAD	MEAN SQUARE	NUM OF
2	NAME	BASIN	GROUP	MT\YR	ERR(MT\YR)**2	SAMPLES
1	ST LOUIS	SUPE	1	17.2	136.6	4
2	BOIS BRULE	SUPE	1	3.3	0.2	9
3	NEMADJI	SUPE	1	3.5	0.5	10
4	BAD	SUPE	1	15.9	213.8	10
5	NEMADJI	SUPE	1	3.5	0.6	9
6	MONTREAL WIS	SUPE	1	4.2	0.9	9
7	TAHQUAMENON	SUPE	2	2.6	0.9	12
8	ONTONAGAN	SUPE	2	17.1	5.8	12
9	PRESQUE ISLE	SUPE	2	0.8	0.0	12
10	STURGEON	SUPE	2	2.5	0.2	12
11	CARP	SUPE	2	13.5	17.7	8
12	ONTONAGAN	SUPE	2	17.1	5.8	12
13	OCONTO	MICH	1	10.0	83.5	11
14	PESHTIGO	MICH	1	5.0	4.3	11
15	FOX	MICH	1	69.6	227.2	12
16	PENSAUKEE	MICH	1	0.5	0.0	11
17	MANITOWOC	MICH	1	7.2	13.4	11
18	KEWAUNEE	MICH	1	10.7	19.5	10
19	E TWIN	MICH	1	8.0	0.6	11
20	SHEBOYGAN	MICH	1	13.5	18.8	11
21	ROOT	MICH	1	6.7	14.7	10
22	MENOMINEE	MICH	1	6.6	0.8	12
23	ST JOSEPH	MICH	3	61.0	382.4	12
24	KALAMAZOO	MICH	3	72.0	39.0	12
25	GRAND	MICH	3	268.5	108.5	243
26	MUSKEGON	MICH	4	6.5	1.9	12
27	MANISTEE	MICH	4	16.2	9.5	12
28	BOARDMAN	MICH	4	1.2	0.1	12
29	*MANISTIQUE	MICH	4	7.2	3.2	12
30	WHITEFISH	MICH	4	0.7	0.0	12
31	ESCANABA	MICH	4	16.2	36.3	12
32	FORD	MICH	1	1.2	1.2	12
33	THUNDER BAY	HURO	1	2.1	0.3	12
34	RIFLE	HURO	1	2.0	0.1	12
35	AU GRES	HURO	1	0.6	0.0	12
36	CHEBOYGAN	HURO	1	2.0	0.1	12
37	AU SABLE	HURO	1	4.5	0.9	12
38	PINE	HURO	1	7.1	0.2	12
39	SAGINAW	HURO	2	292.4	2589.3	24
40	GENESEE	ONTA	1	90.9	237.8	9
41	OSWEGO	ONTA	2	714.8	114769.9	11
42	BLACK NY	ONTA	3	26.6	78.1	8
43	RAQUETTE	ONTA	3	13.5	35.4	7
44	GRASS	ONTA	3	28.6	6.7	7
45	OSWEGATCHIE	ONTA	3	14.8	17.5	8

SOLUBLE ORTHO PHOSPHORUS 1978

1 2	TRIBUTARY NAME	LAKE BASIN	RIVER GROUP	LOAD MT\YR	MEAN SQUARE ERR(MT\YR)**2	NUM OF SAMPLES
1	BOIS BRULE	SUPE	1	3.5	1.1	7
2	NEMADJI	SUPE	1	5.4	0.7	8
3	MONTREAL	SUPE	1	6.2	0.2	12
4	OCONTO	SUPE	1	3.1	0.0	13
5	BAD	SUPE	1	10.6	1.5	12
6	TAHQUAMENON	SUPE	2	4.7	1.4	12
7	PRESQUE ISLE	SUPE	2	0.6	0.0	11
8	STURGEON	SUPE	2	6.2	4.3	11
9	ONTONAGAN	SUPE	2	16.4	9.3	11
10	FORD	MICH	1	0.5	0.0	12
11	MENOMINEE	MICH	1	18.9	25.9	12
12	PESHTIGO	MICH	1	31.6	394.0	4
13	PENSAUKEE	MICH	1	2.9	0.4	12
14	KEWAUNEE	MICH	1	11.6	4.2	13
15	E. TWIN	MICH	1	5.4	5.7	12
16	MANITOWOC	MICH	1	41.3	102.4	12
17	SHEBOYGAN	MICH	1	44.0	188.9	12
18	ROOT	MICH	1	29.4	115.8	12
19	FOX	MICH	1	189.1	1188.7	12
20	ST JOSEPH	MICH	3	48.7	139.4	12
21	KALAMAZOO	MICH	3	66.9	51.9	12
22	GRAND	MICH	3	232.9	568.5	22
23	MANISTEE	MICH	4	12.2	3.0	12
24	MUSKEGON	MICH	4	11.4	4.1	12
25	BOARDMAN	MICH	4	1.5	0.1	12
26	*MANISTIQUE	MICH	4	11.0	15.1	12
27	WHITEFISH	MICH	4	0.4	0.0	12
28	ESCANABA	MICH	4	16.0	41.0	12
29	THUNDER BAY	HURO	1	1.8	0.2	12
30	RIFLE	HURO	1	2.8	0.2	12
31	AU GRES	HURO	1	2.0	0.2	12
32	AU SABLE	HURO	1	3.8	0.2	12
33	PINE	HURO	1	12.3	5.0	12
34	CHEBOYGAN	HURO	1	2.7	0.3	12
35	SAGINAW	HURO	2	240.0	859.5	23

SUSPENDED SOLIDS 1977

1	TRIBUTARY	LAKE	RIVER	LOAD	MEAN SQUARE	NUM OF
2	NAME	BASIN	GROUP	MT\YR	ERR(MT\YR)**2	SAMPLES
1	ST LOUIS	SUPE	1	9089.7	1948354.0	12
2	BOIS BRULE	SUPE	1	2063.6	83040.6	11
3	BAD	SUPE	1	42851.0	835567872.0	24
4	NEMADJI	SUPE	1	62033.4	1.0	365
5	MONTREAL	SUPE	1	1185.1	89920.0	12
6	TAHQUAMENON	SUPE	2	20875.6	72768160.0	24
7	PRESQUE ISLE	SUPE	2	1079.9	212137.1	12
8	STURGEON	SUPE	2	40503.2	672361472.0	12
9	CARP	SUPE	2	483.8	36500.6	8
10	ONTONAGAN	SUPE	2	217354.5	6751281152.0	24
11	FORD	MICH	1	2313.1	202748.8	24
12	OCONTO	MICH	1	7690.8	11942845.0	11
13	PESHTIGO	MICH	1	3506.9	1544790.0	11
14	FOX	MICH	1	46105.8	50877792.0	25
15	PENSAUKEE	MICH	1	214.7	6347.7	11
16	MANITOWOC	MICH	1	1464.9	24563.6	11
17	KEWAUNEE	MICH	1	544.3	15974.4	10
18	E TWIN	MICH	1	1943.6	21974.4	11
19	SHEBOYGAN	MICH	1	4334.8	1090685.0	11
20	ROOT	MICH	1	4762.2	9028218.0	12
21	MENOMINEE	MICH	1	7275.4	1492029.0	12
22	MILWAUKEE	MICH	2	9960.1	2908796.0	12
23	ST JOSEPH	MICH	3	68767.9	181685968.0	12
24	KALAMAZOO	MICH	3	23008.2	6343270.0	24
25	GRAND	MICH	3	47046.9	8685259.0	242
26	MUSKEGON	MICH	4	15583.7	29611104.0	24
27	MANISTEE	MICH	4	12903.0	2009144.0	24
28	BOARDMAN	MICH	4	483.3	9383.2	12
29	*MANISTIQUE	MICH	4	10855.1	7513681.0	24
30	WHITEFISH	MICH	4	2131.6	404750.7	12
31	ESCANABA	MICH	4	3382.1	185289.4	24
32	THUNDER BAY	HURO	1	2548.7	295204.1	12
33	RIFLE	HURO	1	5807.2	1185211.0	24
34	AU GRES	HURO	1	1168.1	63280.9	12
35	CHEBOYGAN	HURO	1	4331.3	770389.8	23
36	AU SABLE	HURO	1	2735.2	259207.5	12
37	PINE	HURO	1	114697.8	3859277312.0	12
38	SAGINAW	HURO	2	64408.5	149306144.0	36
39	GENESEE	ONTA	1	331790.0	8261558272.0	9
40	OSWEGO	ONTA	2	85778.8	286345472.0	16
41	BLACK NY	ONTA	3	24756.8	10119396.0	15
42	RAQUETTE	ONTA	3	4693.8	1426200.0	8
43	GRASS	ONTA	3	3853.2	85489.8	8
44	OSWEGATCHIE	ONTA	3	11446.0	731309.7	8

SUSPENDED SOLIDS 1978

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 1      TRIBUTARY      LAKE  RIVER          LOAD       MEAN SQUARE     NUM OF
 2       NAME         BASIN GROUP          MT\YR    ERR(MT\YR)**2    SAMPLES

 1       BOIS BRULE   SUPE    1           3858.1         6293354.0      7
 2       MONTREAL     SUPE    1            873.7           39486.0     12
 3       OCONTO       SUPE    1           4361.1         3574437.0      9
 4       BAD          SUPE    1          19835.1        14110186.0     12
 5       ST LOUIS     SUPE    1         102791.1       404097280.0      8
 6       NEMADJI      SUPE    1         122145.8               1.0    365
 7       PRESQUE ISLESUPE    2           1510.2          386464.1     11
 8       STURGEON     SUPE    2          18867.8        75845680.0     11
 9       TAHQUAMENON  SUPE    2           4367.5          851029.6     22
10       ONTONAGON    SUPE    2         119178.6      4508045312.0     19
11       MENOMINEE    MICH    1          20842.6        47809648.0     12
12       FORD         MICH    1           8840.4        18321872.0     24
13       PESHTIGO     MICH    1           5970.7        13177562.0      4
14       PENSAUKEE    MICH    1            357.3           19902.6     12
15       KEWAUNEE     MICH    1           3543.0         7616410.0     27
16       E. TWIN      MICH    1           2521.4         2319370.0     12
17       MANITOWOC    MICH    1          13622.2        75933712.0     12
18       SHEBOYGAN    MICH    1          18632.5        62755536.0     12
19       ROOT         MICH    1           5481.1         6395605.0     12
20       FOX          MICH    1         170370.8      1519745024.0     23
21       MILWAUKEE    MICH    2          38988.7       457587712.0     12
22       ST JOSEPH    MICH    3          71771.6       206378240.0     12
23       KALAMAZOO    MICH    3          30821.8         7821415.0     24
24       GRAND        MICH    3          62931.4       615050496.0     22
25       MUSKEGON     MICH    4          24107.8       101734000.0     24
26       MANISITEE    MICH    4          14997.8         2351714.0     24
27       *MANISTIQUE  MICH    4          11905.7         2462751.0     23
28       ESCANABA     MICH    4           6376.8         3067304.0     23
29       BOARDMAN     MICH    4            710.2           44856.0     12
30       WHITEFISH    MICH    4           2397.6          651620.2     12
31       CHEBOYGAN    HURO    1           3175.1          136764.1     23
32       THUNDER BAY  HURO    1           2445.6          232684.2     12
33       AU GRES      HURO    1           3761.2          403842.3     12
34       AU SABLE     HURO    1           5864.1          530202.6     12
35       PINE         HURO    1          81048.3      3366283520.0     12
36       RIFLE        HURO    1          13906.1        15346037.0     23
37       SAGINAW      HURO    2         148927.7      1682731264.0     35
38       GENESEE      ONTA    1         541773.8      5814403072.0      8
39       OSWEGO       ONTA    2        1754859.0   1063638466560.0      7
40       BLACK NY     ONTA    3          97522.0      2624797696.0     12
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CHLORIDE 1977

i 2	TRIBUTARY NAME	LAKE BASIN	RIVER GROUP	LOAD MT\YR	MEAN SQUARE ERR(MT\YR)**2	NUM OF SAMPLES
1	ST LOUIS	SUPE	1	15616.9	4291579.0	15
2	BOIS BRULE	SUPE	1	159.6	1824.1	4
3	NEMADJI	SUPE	1	809.5	7919.3	17
4	BAD	SUPE	1	1993.5	30237.8	17
5	MONTREAL	SUPE	1	5659.4	8128852.0	12
6	TAHQUAMENON	SUPE	2	2037.5	163365.9	24
7	PRESQUE ISLE	SUPE	2	411.4	9134.4	12
8	STURGEON	SUPE	2	1054.5	12579.4	12
9	CARP	SUPE	2	922.2	36570.5	8
10	ONTONAGAN	SUPE	2	2435.1	72546.3	24
11	FORD	MICH	1	552.4	777.2	24
12	OCONTO	MICH	1	4759.6	7016444.0	2
13	FOX	MICH	1	36054.1	4278481.0	23
14	PESHTIGO	MICH	1	2487.1	1083910.0	3
15	MANITOWOC	MICH	1	1265.7	242.8	3
16	PENSAUKEE	MICH	1	407.8	1391.9	3
17	SHEBOYGAN	MICH	1	3402.8	31126.2	11
18	KEWAUNEE	MICH	1	662.1	156.9	4
19	E TWIN	MICH	1	1649.1	664.1	3
20	ROOT	MICH	1	3826.1	10035518.0	13
21	MENOMINEE	MICH	1	5254.4	51383.3	12
22	ST JOSEPH	MICH	3	68252.9	17673472.0	12
23	KALAMAZOO	MICH	3	48568.1	4080633.0	24
24	GRAND	MICH	3	95561.2	5913592.0	242
25	MUSKEGON	MICH	4	35364.2	1124774.0	24
26	MANISTEE	MICH	4	74895.2	20602976.0	24
27	BOARDMAN	MICH	4	1698.0	3850.0	12
28	*MANISTIQUE	MICH	4	2983.9	9303.8	24
29	WHITEFISH	MICH	4	916.8	4966.8	12
30	ESCANABA	MICH	4	6994.9	3233628.0	24
31	THUNDER BAY	HURO	1	3107.2	13758.1	12
32	RIFLE	HURO	1	3788.5	27410.9	23
33	AU GRES	HURO	1	2465.1	124232.8	12
34	CHEBOYGAN	HURO	1	5197.5	24485.3	24
35	AU SABLE	HURO	1	6900.1	32722.9	12
36	PINE	HURO	1	509.7	53371.8	12
37	SAGINAW	HURO	2	156433.6	326451456.0	36
38	GENESEE	ONTA	1	141060.0	245217968.0	17
39	OSWEGO	ONTA	2	965441.2	8674615296.0	23
40	BLACK NY	ONTA	3	10050.5	378230.4	21
41	RAQUETTE	ONTA	3	3106.1	40695.0	8
42	GRASS	ONTA	3	4131.3	266603.0	8
43	OSWEGATCHIE	ONTA	3	5738.6	218398.8	8

CHLORIDE 1978

1	TRIBUTARY	LAKE	RIVER	LOAD	MEAN SQUARE	NUM OF
2	NAME	BASIN	GROUP	MT\YR	ERR(MT\YR)**2	SAMPLES
1	ST LOUIS	SUPE	1	25044.5	10710756.0	8
2	NEMADJI	SUPE	1	1125.0	31860.7	12
3	TAHQUAMENON	SUPE	2	2453.3	273370.9	24
4	ONTONAGON	SUPE	2	4075.3	426324.8	23
5	PRESQUE ISLE	SUPE	2	606.5	5766.9	11
6	STURGEON	SUPE	2	2353.3	372009.9	11
7	FORD	MICH	1	1028.0	7504.1	24
8	MENOMINEE	MICH	1	7793.5	555200.3	12
9	FOX	MICH	1	52688.1	4387524.0	24
10	MILWAUKEE	MICH	2	17144.2	37398480.0	12
11	ST JOSEPH	MICH	3	73069.6	40175392.0	12
12	KALAMAZOO	MICH	3	57381.6	7487332.0	24
13	GRAND	MICH	3	115942.4	417755904.0	22
14	MUSKEGON	MICH	4	39154.7	1905141.0	24
15	MANISITEE	MICH	4	71765.8	11505364.0	24
16	*MANISTIQUE	MICH	4	4202.0	176220.2	24
17	ESCANABA	MICH	4	7636.0	3358910.0	24
18	BOARDMAN	MICH	4	2114.3	1329.6	12
19	WHITEFISH	MICH	4	659.9	3988.9	12
20	THUNDER BAY	HURO	1	3825.4	142194.7	12
21	AU GRES	HURO	1	3959.6	369314.9	12
22	AU SABLE	HURO	1	7838.7	27379.3	12
23	PINE	HURO	1	689.2	15867.4	12
24	RIFLE	HURO	1	5678.2	38973.6	23
25	CHEBOYGAN	HURO	1	6821.5	158284.5	24
26	SAGINAW	HURO	2	202946.5	1172546560.0	35
27	GENESEE	ONTA	1	180482.2	3400893440.0	8
28	OSWEGO	ONTA	2	1154653.0	6204534784.0	12
29	BLACK NY	ONTA	3	9404.4	1990879.0	12

APPENDIX E

SELECTED DESCRIPTIONS OF CURRENT AGRICULTURAL RESEARCH PROJECTS ON THE CAUSES AND CONTROL OF NONPOINT SOURCE POLLUTION

This Appendix contains descriptions of the select group of research projects referred to in Chapter 4. All of the listings, with the exception of the first two, were obtained from CRIS and are presented in the format of the original retrieval. Information given includes:

1. sponsoring agency
2. period of investigation
3. name of the researcher
4. project location
5. description of project objectives, approach and progress; and
6. recent publications.

AGENCY: NOAA (SEA GRANT)[1]
PERIOD: FY 78, FY 79
INVEST: BROMLEY D W
LOCATION: UNIV OF WISCONSIN

NONPOINT SOURCE POLLUTION IN GREEN BAY AND ITS IMPLICATION FOR WATER QUALITY MANAGEMENT

OBJECTIVES: To analyze the implications of current and conservation-oriented land use practices on the quality of receiving waterways in the Green Bay area. To simulate alternative comprehensive management policies and evaluate their impact on water quality in the lower Fox River-Green area.

AGENCY: OHIO STATE GOVERNMENT[2]
INVEST: NOLTE B
PERF ORG: OHIO AGRI R&D CTR
LOCATION: COLUMBUS OHIO

PHOSPHORUS BIOAVAILABILITY STUDY FOR LAKE ERIE TRIBUTARIES

OBJECTIVE: Determine the fraction of total P in suspended sediments entering Lake Erie that is biologically available. Develop a simple model to predict available P loadings to Lake Erie from suspended sediments.

APPROACH: Suspended sediments will be sampled during storm events in eight tributaries draining into Lake Erie. The biologically available P in the sediment will be determined by algae bioassay and chemical extraction procedures and the results correlated. P bioavailability will also be correlated with routine sediment characteristics and predictive equations for available P flux will be developed.

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1. Project description obtained from the publication, Catalog of Federal Ocean Pollution Research Development and Monitoring Programs, Fiscal Years 1978-1980.

2. Project description obtained from WRE.

0073469
AGENCY: CSRS WIS
PERIOD: 01 JUL 77 TO 30 SEP 79
INVEST: HILSENHOFF W L
PROJECT#: WIS02338
PERF ORG: ENTOMOLOGY
LOCATION: UNIV OF WISCONSIN
MADISON WIS

EFFECTS OF LIVESTOCK GRAZING PRACTICES ON THE WATER QUALITY OF STREAMS

OBJECTIVES: Document effects of pasturing cattle on the fauna and water quality of streams. Determine factors associated with the congregation of cattle in streams. Determine relationships of cattle weight, stream flow, cattle access, and water quality.

APPROACH: Replicated laboratory tests will be carried out in artificial streams at various temperatures and current velocities to determine effects of different amounts of cattle manure in the water on selected aquatic insects known to be sensitive to organic pollution. The arthropod fauna of a stream from which cattle have been fenced will be compared before and after fencing and with a control stream. Other streams will be observed to determine how many cattle can be pastured and under what conditions before the ecosystem of a stream is altered.

KEYWORDS: CATTLE MANURE WATER-QUALITY STREAMS INSECTS POLLUTION LIVESTOCK GRAZING WATER WATER-POLLUTION PASTEURIZATION AQUATIC-INSECTS WATER-FLOW ANIMAL-WASTE

PROGRESS:77/01 77/12
One artificial stream with two 8-foot sections has been constructed from 3/4 inch plywood covered with several layers of fiberglass to make it waterproof. The stream channels are supported, one above the other, on a frame of 2-inch angle iron with a movable support that allows the pitch of each stream to be varied, thus changing the current. Plastic pipe and rubber hoses have been used for the circulation of water to avoid contact with metal ions.

PUBLICATIONS:77/01 77/12
NO PUBLICATIONS REPORTED THIS PERIOD.

AGENCY: CSRS ILLU
PERIOD: 12 JUL 76 TO 30 SEP 79
INVEST: VANDERHOLM D H
PROJECT#: ILLU-10-0311
PERF ORG: AGRI ENGINEERING
LOCATION: UNIV OF ILLINOIS
URBANA ILL

HOME SEWAGE SYSTEMS FOR AREAS WITH SOILS UNSUITABLE FOR SUBSURFACE SEEPAGE FIELDS

OBJECTIVES: Identify alternative home sewage systems which indicate potential for satisfactory performance in areas where soil conditions are unsuitable for subsurface seepage fields. Evaluate the performance of alternative home sewage systems under field conditions. Modify and adapt promising home sewage systems to enhance their performance and acceptability. If necessary, develop home sewage systems with new concepts suitable for use where subsurface disposal is unfeasible or impractical.

APPROACH: Install and monitor sewage systems identified in 1 above. Augment field studies with laboratory study of individual components or processes. Modify systems when monitoring indicates changes are adviseable.

KEYWORDS: SEWAGE AEROBIC-TREATMENT SEPTIC-TANKS SEWAGE-TREATMENT OXIDATION LAGOONS SAND FILTERS ALTERNATIVES PERFORMANCE SEPTIC-SYSTEMS SOILS EVALUATION WATER-POLLUTION SOIL-POLLUTION WASTE-DISPOSAL

PROGRESS:77/01 77/12
Two commercial aerobic treatment units and one recirculating sand filter treatment unit were installed at Dixon Springs Agricultural Center. These are being tested under different operating conditions for evaluating acceptability of treated sewage for discharge. Several filter sands with different size characteristics are being tested, both in laboratory column studies and in the field system. Operational problems associated with the new systems are being solved and the coming year will be devoted to collection and analysis of data.

PUBLICATIONS:77/01 77/12
NO PUBLICATIONS REPORTED THIS PERIOD.

0070930

0058307
AGENCY: SAES NY.C
PERIOD: 01 JUL 70 TO 03 OCT 79
INVEST: OGLESBY R T
PROJECT#: NYC-147308
PERF ORG: NATURAL RESOURCES
LOCATION: CORNELL UNIV
ITHACA NY

EUTROPHICATION AND COMPERATIVE LIMNOLOGY OF THE FINGER LAKES

OBJECTIVES: Develop quantitative models applicable to the management of phytoplankton levels, water clarity and fish production in the Finger Lakes. Continue verification of hypothesis that soluble phosphorus inputs are the principal determinants of water quality. Continue work with interdisciplinary group studying the origins of phosphorus entering lakes with emphasis on diffuse sources.

APPROACH: Intensive review of information on globally distributed lakes to ascertain validity of models developed for the Finger Lakes. Institute a new surveillance program for the Finger Lakes to determine if the 1973 abolition of phosphate containing detergents in New York State has produced the predicted changes. Participated in exchanges with other scientists and administrators of water quality programs through special conferences and workshops.

KEYWORDS: MODELS ALGAE PLANKTON WATER-QUALITY STREAMS NUTRIENTS WATER-POLLUTION LIMNOLOGY RUNOFF EUTROPHICATION LAKES NITROGEN MANAGEMENT NUTRIENT-MOVEMENT WATERSHEDS PHYTOPLANKTON ZOOPLANKTON PHOSPHORUS SOURCES DETERGENTS WATERSHED-MODELS WATERSHED-MANAGEMENT

PROGRESS:77/01 77/12
The principal activities carried out under this project during 1977 consisted of additional data analyses and the final preparation of material for publishing. Samples were collected from nine of the lakes on one occasion during the winter for total phosphorus analysis and on three occasions in the summer for more complete chemical and biological examination. The objective was to determine what effects, if any, the New York State 1973 ban on phosphorus in household laundry detergents may have had on water quality. Results were ambiguous. A study of data collected in previous years suggests that levels of variability due to causes other than phosphorus loading are high enough to mask effects unless a number of years of data are obtained.

PUBLICATIONS:77/01 77/12
OGLESBY, R. T. 1977. Phytoplankton summer standing crop and annual productivity as functions of phosphorus loading and various physical factors. J. Fish. Res. Board Can. 34:2255-2270.
OGLESBY, R. T. 1977. Relationships of fish yield to lake phytoplankton standing crop, production, and morphoedaphic factors. J. Fish. Res. Board Can. 34:2271-2279
BOULDIN, D. R.; CAPENER, H. R.; CASLER, G. L.; DURFEE, A. E; LOEHR, R. C.; OGLESBY, R. T.; and YOUNG, R. J. 1977. Lakes and phosphorus input: a focus on management. Information Bulletin 127. N.Y. State College of Agriculture and

0001617
AGENCY: CSRS WIS
PERIOD: 01 JUL 63 TO 30 SEP 80
INVEST: CONVERSE J C; BUBENZER G D
PROJECT#: WIS05008-6008
PERF ORG: AGRI ENGINEERING
LOCATION: UNIV OF WISCONSIN
MADISON WIS

ANIMAL WASTE MANAGEMENT SYSTEMS FOR THE 1980'S

OBJECTIVES: Develop optimal animal manure management systems to meet the evolving environmental and economic requirements and be compatible with the increasing needs of our nation and the world for animal protein. Investigate use of by-products of animal manure management systems for energy source feed ingredients, plant nutrients for crop production and other potential uses with consideration of the human, animal and plant health factors. Characterize the non-point population water runoff sources from livestock and poultry enterprises on pasture production systems and land areas with manure application and to further develop guidelines for abatement of non-pollution sources from animal manure.

APPROACH: Anaerobic digesters for poultry and dairy cattle manure are being evaluated for energy inputs and outputs, solids degradation, of gas composition and fertilizer value. A liquid manure handling system is being developed for dairy replacements utilizing manure scraping with and without slatted floors. A manure nutrient runoff model is being developed to predict nutrient movement of winter applied manure during spring runoff. Barnyard runoff and nutrient movement is being evaluated for medium size dairy herds on earthen lots for five different soil conditions. Protein production utilizing photosynethic bacteria and anaerobic digested effluents is being evaluated.

KEYWORDS: MANURE MANURE-MANAGEMENT WASTE-COLLECTION WASTE-TRANSPORT WASTE-MANAGEMENT WASTE-TREATMENT WASTE-UTILIZ-ATION WASTE-DISPOSAL ANIMAL-WASTE ANAEROBIC-DIGESTION POULTRY-MANURE ENERGY #ENS LIQUID-MANURES PROTEINS METHANE ANIMAL-NUTRITION PLANT-NUTRITION RUNOFF POLLUTION PASTURES LAND-APPLICATION BYPRODUCTS #ERP

PROGRESS:77/01 77/12
Sediment depsition patterns and nutrient reductions in a grass filter loaded with dairy barnyard runoff is being evaluated on a runoff table 1 meter wide and 5 meters long. The grass filter is cut sod, placed over 100 mm of sand and soil incorporating a suction system to approximate actual infiltration characteristics. Barnyard sediment is applied at rates of 0.5 and 1.0% total solids concentration. Preliminary analysis of runoff indicates removal of 87-95% total solids, 88-98%. of Kheldahl nitrogen and 90-97% total phosphoruous by the grass filter. Solid, liquid and semi- solid manure storages are being evaluated for nutrient concentration to obtain a range of expected concetrations. Liquid manure is being applied at rates of 30 tons/acre (equivalent to 5, 2.5 and 5 fert.) to corn land with fall and spring applications. Manure is applied by surface spreading and without incorporation and injection. 150 lbs. of 18-46-0 starter fertilizer is applied. Corn yields and soil fertility will be evaluated over a 3 years period. A 96 m(3) layer poultry digester with floating cover and operated at 35 degrees C has been operating for 2 years. Detention times range from 30-50 days with loading rates of 1.6 - 2.9 kg vs/m./d. Total solids of feed ranged from 8 - 13% with 63-67% V.S. NH(3) concentration was 6500-8000 mg/1 and pH of 7.7 - 8.0. Gas production ranged from 0.6 - 0.8 m./m./d. Net energy output ranged from 49% during winter to 75% during summer.

PUBLICATIONS:77/01 77/12
STEENHUIS, T.S., BUBENZER, G.D. and WALTER, M.F. 1977. Water movement and infiltration in frozen soil: theoretical and experimental considerations. ASAE Paper No. 77.2545.
CONVERSE, J.C., GRAVES, R.E., and EVANS, G.W. 1977. Aneaerobic degradation of dairy manure under mesophilic and thermophilic temperatures. Trans of ASAE 20:336-340.
CONVERSE, J.C., EVANS, G.W., VERHOEVEN, C.R. 1977. Performance of large size anaerobic digester for poultry manure. ASAE Paper No. 77-0451.
STEENHUIS, T.S. 1978. Modeling nigrogen and other nutrient losses from winter spread manure PHD Thesis, University of Wisconsin - Madison.

0057926
AGENCY: CSRS MICL
PERIOD: 01 JUL 70 TO 30 SEP 80
INVEST: GERRISH J B
PROJECT#: MICL01066
PERF ORG: AGRI ENGINEERING
LOCATION: MICHIGAN STATE UNIV
EAST LANSING MIC

ANIMAL WASTE MANAGEMENT SYSTEMS FOR THE 1980'S

OBJECTIVES: Develop optimal animal manure management systems. Characterize atmospheric contaminants and develop abatement methods to eliminate the contaminants' potentially harmful effects on human and animal health. Investigate use of by-products of animal manure management systems for energy sources, feed ingredients, plant-nutrients and other potential uses. Characterize the non-point pollution water runoff sources from livestock and poultry enterprises on pasture production systems and land areas with manure application and to further develop guidelines for abatement of non-point pollution sources from animal manures.

APPROACH: Study hydraulic transport of manure as practiced in flushing systems. This will lead to design recommendations and workable plans. Modelling studies are already well underway. In odor control, we are studying the effects of ozone on swine waste. Also studying the culture of purple sulfur bacteria as an odor modifier in anaerobic lagoons. Hope to develop procedures to foster such a culture under Michigan climatic conditions. Studying liquid-solid separation for its potential as a step in a fermentation process leading to a re-fed product. Have two year's data from some spring-thaw runoff events at a system of 12 plots where manure was applied on the frozen ground. This study will continue in an attempt to develop control strategies which would minimize non-point source pollution. (20% basic research; 60% applied research; 20% development effort).

KEYWORDS: POLLUTION-ABATEMENT DAIRY-CATTLE MANURES WATER-POLLUTION AIR-POLLUTION ODOR-CONTROL TRANSPORT SWINE RUNOFF WASTE-MANAGEMENT OZONE ANIMAL-WASTE ANAEROBIC-CONDITIONS MODELING ENERGY-SOURCES #ENS FEED PLANT-NUTRIENTS LAGOONS SOIL-APPLICATION FROZEN-SOILS BYPRODUCTS #ERP

PROGRESS:78/01 78/12
Work with the anaerobic swine waste lagoons at MSU has led to new insights in design and management of such lagoons. A system involving two lagoons has been shown effective in reducing the time during which odors can be produced; the basic features of the system include a strategy to preserve a population of purple sulfur bacteria during the cold Michigan winter by maintaining one of the two lagoons in a lightly loaded state throughout the winter. In the spring it has little scum, good light penetration, and warms up quickly so bacteria become active early. A mathematical model has been developed to provide a quantitative analysis of the purple sulfur bacterial processes in a lagoon. The model predicts hydrogen sulfide production. Purple sulfur bacteria show promise of being a useful odor control mechanism for lagoons even in our cold Michigan climate. Analysis of data from an iconic model of under slat swine waste flushing has led to the development of a mathematical approach for designing under slat flushing systems. This approach should be a valuable tool for accurately predicting the performance of a system before it is built.

PUBLICATIONS:78/01 78/12
VAN LOTRINGEN, T.J.M. (1978). Control of Hydrogen Sulfide Odors from Anaerobic Lagoons by Purple Sulfur Bacteria. Unpublished Ph.D. Thesis. Agricultural Engineering Department, Michigan State University.
VAN LOTRINGEN, T.J.M. and GERRISH, J.B. (1978). H2S Removal by Purple Sulfur Bacteria in Swine Waste Lagoons.

0072425
AGENCY: SAES OHO
PERIOD: 01 NOV 76 TO 31 OCT 79
INVEST: WHITE R K; VAN KEUREN R W; EDWARDS W
PROJECT#: OHO00255
PERF ORG: AGRI ENGINEERING
LOCATION: OHIO AGRICULTURAL R AND D CENTER
COLUMBUS OHO

EFFECT OF PASTURING ON NON-POINT SURFACE RUN-OFF

OBJECTIVES: Establish the contribution of pollutants from livestock pasturing (non-point sources), to identify management practices that can be used to significantly reduce non-point surface runoff pollution and to predict what will happen to hydrologic and water quality parameters in non-point surface runoff from livestock pastures. The following specific objectives will be addressed: Obtain hydrologic and chemical data for each runoff event on selected watershed. Evaluate hydro-chemical data for selected watersheds and compare with hydrologic history of the watersheds to identify hydrologic factors and management practices that contribute to or decrease contribution of pollutants to non-point surface runoff. Establish the degree of bacterial pollution present in non-point surface runoff from cattle pastures during different periods of the year.

APPROACH: Samples will be taken periodically throughout storm events from watersheds where beef cattle are pastured as follows: Summer rotational pasturing and winter feeding with hay brought to the cattle; only summer rotational pasturing and winter feeding on field stored hay and saved autumn regrowth. The samples will be analyzed for N,P, TOC, BOD, COD, sediment yield and sediment N and P.

KEYWORDS: WATER-CHEMISTRY ROTATIONAL-GRAZING MANAGEMENT SEDIMENT-YIELD BACTERIA WATER-POLLUTION PREDICTION SEASONAL-HISTORY NON-POINT-POLLUTION WATERSHEDS SURFACE-WATER POLLUTION PHOSPHORUS HYDROLOGY NITROGEN WATER-QUALITY WASTE-MANAGEMENT CATTLE PASTURES SEDIMENTS RUNOFF

PROGRESS:78/01 78/12
Two years of data have been collected on three watersheds with different pasturing regimes. A control watershed is also being monitored. Runoff samples are being analyzed for N (NH(3), NO(2)/NO(3), and total N), total P, TOC, COD, BOD, sediment yield and sediment N and P. Also monthly samples for microbiological analyses are collected and tested for total coliform, fecal coliform and fecal streptococci. A complete record of pasture and livestock management is being kept. Data are being analyzed for effects of pasturing on runoff quantity and quality. Data collection will end on October 31, 1979. Project will continue for an additional five months to allow for data reduction, summarization and evaluation.

PUBLICATIONS:78/01 78/12

NO PUBLICATIONS REPORTED THIS PERIOD.

0064026
AGENCY: CSRS PEN
PERIOD: 01 JUL 74 TO 30 SEP 79
INVEST: SOPPER W E; LYNCH J A; CORBETT E S
PROJECT#: PEN02113
PERF ORG: FOREST RESOURCES
LOCATION: PENNSYLVANIA STATE UNIVERSITY
UNIVERSITY PARK PA

EFFECTS OF FOREST WATERSHED MANAGEMENT PRACTICES ON WATER YIELD AND QUALITY

OBJECTIVES: Evaluate the effects of forest clearcutting and herbicide vegetation control on water yield and water quality.

APPROACH: Three completely instrumented experimental forested watersheds will be used in the study. One of the watersheds is approximately 50 percent clearcut. Herbicides are being used to control vegetation regrowth. Streamflow and precipitation records will be used to determine changes in water yield quantity. Water samples will be collected weekly at four locations along the stream channel in each watershed to evaluate the effects of the progressive clearcutting on water quality.

KEYWORDS: REVEGETATION WATER HYDROLOGY PRECIPITATION MANAGEMENT RUNOFF FORESTRY WATERSHEDS FOREST-CLEARCUTTING HERBICIDES CLEARCUTTING WATERSHED-MANAGEMENT FOREST-MANAGEMENT WATER-QUALITY WATER-YIELD FOREST-WATERSHEDS STREAM-FLOW

PROGRESS:78/01 78/12
1978 nutrient concentration data indicated that NO(sub 3)-N and K continued to be significantly higher on the clearcut-herbicided watershed than on the undisturbed watershed, but at levels lower than recorded in 1977. Interestingly, the highest NO(sub 3)-N data occurred at the headwaters and progressively decreased towards the mouth of the watershed. This apparently resulted because of the larger amount of logging residue and undecomposed organic matter on the more recently cut-herbicided upper portion of the watershed than on the lower portion and the greater potential for increased nutrient leaching due to soil condition. In addition, some dilution occurred between the headwaters and the mouth of the watershed due to increasing streamflow. Mg, Na, Ca, and SO(sub 4) concentration data and trends did not appear to be significantly different from those previously reported. Turbidity continued to be significantly higher on the treated watershed as a result of increased channel erosion due to increased stream discharge. This is partly due to increased stability of the stream channel. Monitoring of Na, Mg, K, NO(sub 3)-N, SO(sub 4), Ca, turbidity, alkalinity, specific conductance, and stream temperatures is continuing.

PUBLICATIONS:78/01 78/12
CORBETT, E. S., J. A. LYNCH, W. E. SOPPER. 1978. Timber harvesting practices as related to water quality in eastern United States. J. For. 76(8): 484-488.
K. P. 1978. Local perceptions of problem-solving auspices. NE-89 Working LULOFF, A. E., STOKES, C. S. 1977. A Note on Population Size and Community Differentiation in Nonmetropolitan Communities. Soc. and Social Res. 61(4):486-496.
MILLER, M. K., STOKES, C. S. 1978. Health Status, Health Resources and Consolidated Structural Parameters: Implications for Public Health Care Policy. J. Health and Social Behavior 19(3):263-279.
WILKINSON, K. P. 1978. Rural Community Change. Chapter 7 in T. R. Ford (ed.), Rural USA: Persistence and Change. Iowa State University Press, pp. 115-125.
WILKINSON, K. P. 1979. Social Well-Being and Community. J. Community Development Society 10(June) (In press).

0010833
AGENCY: SAES MIN
PERIOD: 01 JUL 47 TO 30 JUN 79
INVEST: ELLEFSON P V
PROJECT#: MIN-42-032
PERF ORG: FORESTRY
LOCATION: UNIV OF MINNESOTA
ST PAUL MIN

ANALYSIS OF MINNESOTA FOREST RESOURCE SUPPLIES, DEMANDS AND MANAGEMENT OPTIONS

OBJECTIVES: Analyze factors which influence the ability of Minnesota's forest resources to provide acceptable flows of forest outputs. Current high priority objectives are to evaluate the economic impact of forest practices and programs undertaken to control nonpoint sources of water pollution, develop measures of the productive capability of Minnesota's forests, and develop a problem analysis of political institutions and political principles impacting forest use and management in Minnesota.

APPROACH: Review current literature, develop procedures for evaluating economic aspects of controlling nonpoint sources of water pollutants and of assessing the productive capacities of Minnesota's forest, apply procedures to selected counties or regions in Minnesota, and analyze the forest policy implications of results obtained when procedure is applied. Problem analysis will involve review of literature, consultation with researchers, administrators and others, and preparation of report specifying problems and the research needed to alleviate such problems.

KEYWORDS: POLICY-FORMULATION COSTS OPPORTUNITIES FINANCIAL-ANALYSIS ECONOMICS FOREST-PRODUCTION POLICIES LAW LEGISLATION FORESTRY ECONOMIC-IMPACT ANALYSIS MEASUREMENT PRODUCTIVITY FOREST-ECONOMICS WATER-POLLUTION

PROGRESS:77/01 77/12
Two public timber sales are being evaluated for economic consequences of managing non-point sources of water pollution. Costs of pollution curbing practices have been gathered and related to timber sale revenues. 17 state forest practice acts and implementing rules are being analyzed to determine forest practices addressed, notification system employed, composition of forest practice board and nature of agency authority. 25 personal interviews to identify preference for a state forest practice and means of implementing it have been completed. Final reports on the biological and economic timber producing potential of Minnesota's forests and on Minnesota special interest groups important to forest policy development are being prepared. Problem analysis of political forces important to development of forest policies has identified agenda-building, criteria, methods of policy research, information sources and types, and institutions (eg. special interest groups) as broad research areas. Peliminary report on use and management of forest land sold by Itasca County has been completed. 474 individuals purchased 13355 ha. between 1960 and 1977. 72 corporations purchased 37232 ha. during same period. Research has been undertaken to define status of vertical and horizontal integration in the wood-based industry, analyze consequences of such integration and identify problems in need of research.

PUBLICATIONS:77/01 77/12
ELLEFSON, P.V. and SPURR, S.H. "Forest Policy Research: An Examination of Research Needs". (1977). In: Research in Forest Economics and Forest Policy Resources for the Future. Washington, D.C.
PALM, S.L. and ELLEFSON, P.V. Paricipants in the Youth Conservation Corps: Case Study of the Bald Eagle Camp. Minnesota Forestry Note No. 265. June 1977.
WALLING, T.K. 1977. Special Interest Groups and Forest Policy Formation: A Case Study of Minnesota. (M.S. Manuscript) Univ. of Minn., St. Paul, MN 70 p.
JAKES, P.J. 1977. The Biological and Economic Potential of Minnesota's Commercial Forest Land to Produce Timber. (M.S. Manuscript) Univ. of Minn., St.
Paul, MN 76 p.
ELLEFSON, P.V. "Focus on Forest Investments: What Policy for SAF?" 1977. Journal of Forestry 75:429-430

0010830
AGENCY: SAES MIN
PERIOD: 01 JUL 68 TO 30 JUN 79
INVEST: BROOKS K N
PROJECT#: MIN-42-035
PERF ORG: FORESTRY
LOCATION: UNIV OF MINNESOTA
ST PAUL MIN

FOREST-WATERSHED MANAGEMENT EFFECTS ON QUANTITY AND QUALITY OF RUNOFF

OBJECTIVES: Develop methodology to evaluate and predict quantity of runoff from forested and other wildland watersheds in Minnesota. Assess forest management and related land use impacts on the quality of runoff in order to develop management guidelines to minimize non-point sources of pollution from forested lands.

APPROACH: Snowmelt and rainfall-runoff prediction models for forested watersheds will be evaluated and modified as needed to conform with data/information availability and Minnesota conditions. Model sensitivity will be tested to determine if land management impacts on the quantity of runoff can be predicted. Non-point pollution problems associated with forestry will be assessed initially on a broad-scale to identify types of quality problems and locations of problem areas in Minnesota. Water quality of runoff from undisturbed forests will be evaluated and contrasted to quality of runoff from managed forests and causative factors will be identified. Prediction models will be developed to facilitate the establishment of management guidelines.

KEYWORDS: FORESTRY FOREST-MANAGEMENT RUNOFF RAINFALL-RUNOFF-RELATION WATER-QUALITY WATER-POLLUTION LAND-USE MODELS PREDICTION WATERSHEDS LAND-MANAGEMENT HYDROLOGY

PROGRESS:77/01 77/12
Study of applications of aerial photography to assess lake water quality on trophic state is completed. B&W aerial photography was used to predict Secchi disk transparency, turbidity, and color. Procedures were developed to use film transmittance--Secchi disk relationships to estimate Carlson's Trophic State Index (TSI). Predicted TSI value for 6 lakes were not different from TSI values determined directly from field data. Methods of evaluating base-line water quality data from undisturbed watersheds are being studied. In addition, onsite evaluation procedures for identifying areas "sensitive" to forest management activities are being developed. Applications of aerial photography will be investigated. Meteorological and hydorlogic measurements will be made for an undisturbed peatland and for sites which will undergo changes associated with peatland drainage and harvesting. Study sites have been selected and instrumentation is in place for the next field season. Stormflow, water yield and water quality will be studied. Three snowmelt prediction models have been tested under different vegetation types in Minnesota. An accumulated degree-day approach, a modified Corps of Engineer generalized snowmelt equation approach, and a modified Leaf-Brink model were investigated. Survival and growth of vegetation planted on iron-ore overburden material which was irrigated with secondary sewage effluent will continue to be measured. 3 to 4 years of data will be collected.

PUBLICATIONS:77/01 77/12
BROOKS, K.N. et al. 1977. Feasibility of using iron-ore overburden material as a media for disposal of secondary sewage effluent in northeastern Minnesota.
Bulletin 93, Water Resources Research Center, Univ. of Minnsota.
BROOKS, K.N. et al. 1977. Assessment of water quality status and trends in Minnesota by remote sensing techniques. OWRT Project Completion Report, College of Forestry, University of Minnesota.
WERTH, L., MEYER, M. and BROOKS, K.N. 1977. A wetlands survey of the Twin Cities 7-County Metropolitan Area-West Half. Institute of Agriculture, Forestry and Home Economics, Remote Sensing Laboratory Research Report 77-10.

0042240
AGENCY: ARS 3505
PERIOD: 27 FEB 75 TO 27 FEB 79
INVEST: YOUNG R A; ONSTAD C A; HOLT R F
PROJECT#: 3505-20800-002
PERF ORG: USDA-ARS TILLAGE WATER USE &
SOIL-PLANT-ATMOS RES
LOCATION: NC SOIL CONSERVATION RES LAB
MORRIS MIN

MECHANICS AND CONTROL OF SOIL EROSION BY WATER-BARNES AND ASSOCIATED SOILS

OBJECTIVES: Particle size distribution of soil eroded from rill and interrill zones and the deposition characteristics of soil particles of various sizes. Study the effect of impacting raindrops on the erosion process in a small rill. Provide data for developing and verifying a comprehensive erosion model.

APPROACH: Using simulated rainfall on laboratory and field plots, study erosion, runoff, and infiltration on at least three soils in a fallow condition on slopes ranging from 4 to 10%. Instrument the outlets and distrubuted upland points of two small watersheds, one primarily agricultural and one forested, and collect soil, water, and nutrient movement data.

KEYWORDS: DEPOSITION INFILTRATION SLOPES SOIL-EROSION EROSION EROSION-CONTROL SOIL-TRANSPORT SOIL-PARTICLES SOIL-LOSS RUNOFF RAINFALL RAINDROP-EROSION SOIL-PROPERTIES SPLASH-EROSION SOILS WATERSHEDS RILL-EROSION MODELS PARTICLE-SIZE

PROGRESS:77/01 77/12
Soil loss from 3 different soils subjected to simulated rainfall was separated into that portion originatiing in rills and that originating in interrill areas. The relative amounts of rill and interril eroded soil were related to soil properties such as aggregation, aggregate stability, organic matter, and particle size distribution. A modified rainulator combined with a sprinkler system was used to measure soil loss and runoff from 22.9 m, 45.7 m, 91.4 m, and 137.2 m long plots. Results will be used to modify the slope length exponent of the USLE for long slope lengths. Three Pacific Northwest soils were tested under simulated rainfall in the laboratory. Erosion from rill and interrill areas was measured separately and sediment characteristics determined for compariosn with midwest soils. Techniques to estimate sediment yields from watersheds have undergone limited testing with good success. In addition to predicting sediment quantities, magnitudes of upland sources are also predicted for the purpose of economic application of conservation practices.

PUBLICATIONS:77/01 77/12
YOUNG, R.A. and MUTCHLER, C.K. Erodibility of some Minnesota soils. Jour. Soil and Water Consev. 32(1977):180-182.
GILLEY, J.E., GEE, G.W., BAUER, A., WILLIS W.O. and YOUNG, R.A. Infiltration at surface-mined sites in western North Dakota. North Dakota Farm Research 34(1976):32-34.
GILLEY, J.E., GEE, G.W., BAUER, A., WILLIS, W.O. and YOUNG, R.A. Runoff and erosion characteristics of surface-mined sites in western North Dakota. Trans. ASAE 20(1977):697-700.
ONSTAD, C.A., YOUNG, R.A., and MOLDENHAUER, W.C. Implementing soil loss limits: some considerations. In Soil Erosion: Prediction and Control. SCSA, Ankeny, Iowa (1977):332-335.
FOSTER, G.R., MEYER, L.D. and ONSTAD, C.A. An erosion equation derived from basic erosion principles. Trans. ASAE 20(4):678-682. (1977).

0075177
AGENCY: SAES WIS
PERIOD: 01 JUL 77 TO 30 JUN 80
INVEST: PETERSON A E; CONVERSE J C; SWANSON R A
PROJECT#: WIS00023-M
PERF ORG: SOIL SCIENCE
LOCATION: UNIV OF WISCONSIN
MADISON WIS

EFFECTIVENESS OF WATER CONTROL PRACTICES FOR PROTECTING RUNOFF WATER QUALITY FROM TURKEY EXERCISE YA

OBJECTIVES: Evaluate the sediment, nutrient and fecal coliform bacteria contributions to surface waters from surface runoff associated with animal feeding/exercise areas. Evaluate movement of nitrates in ground waters in the vicinity of storage ponds, disposal fields used for irrigation purposes or in the grassed waterways. Evaluate changes in physical and chemical properties of soils.

APPROACH: A nutrient budget will be determined by measuring and calculating turkey manure production in the exercise areas and by measuring nutrient losses by runoff and leaching. Measure the nutrients lost by runoff, water stage recorders will be installed in the waterways at both production units to measure total runoff volume. The runoff will be sampled with an ISCO automatic sampler to get uniform sampling of the runoff in the waterway when it occurs. Monitor leaching of nutrients observation wells will be established in exercise area, along grass waterway, and around detention pond for the purpose of sampling and analysis of ground water. Periodic samples of the storage pond will be analyzed and soil samples from the liquid waste irrigated field will be taken for soil analysis. Water analysis will be done, using the "Standard Methods of Water Analysis" of the American Public Health Association. All soil samples will be analyzed through the routine procedure for pH, organic matter, avail. P, avail K and S.

KEYWORDS: RUNOFF WATER-POLLUTION FECAL-COLIFORMS TURKEYS NITRATES GROUND-WATER WATER-QUALITY HYDROLOGY SOIL-CHEMISTRY SOIL-PHYSICS NUTRIENT-BUDGET ANIMAL-WASTE POULTRY-MANURE NUTRIENT-LOSSES WATER-ANALYSIS SOIL-ANALYSIS SEDIMENTS

0044378
AGENCY: ERS NRE
PERIOD: 17 JUL 74 TO 17 JUL 78
INVEST: MCDRITT J
PROJECT#: NRE-41-300-26-01
PERF ORG: NATURAL RESOURCE ECON DIV ERS
LOCATION: MICHIGAN STATE UNIV
EAST LANSING MIC

ECONOMICS OF CONTROLLING AGRICULTURAL NONPOINT POLLUTION

OBJECTIVES: Analyze the aggregate level, alternative sediment, plant nutrient and pesticide pollution abatement policies on production costs, food and fiber prices, and comparative production advantages among regions; determine economically efficient methods available to farmers to achieve alternative levels of pollution control; and develop information on prospective effects of nonpoint pollution abatement on agriculturally related sectors.

APPROACH: Information will be collected on the extent of agricultural nonpoint pollutants and measures to control it. Analytical techniques will range from a partial analysis of the cost effectiveness of various control techniques to regional and national linear programming model. Included in the analysis will be an evaluation of least-cost alternatives for limiting nonpoint pollutants and an appraisal of regional and interregional production effects resulting from pollution control.

KEYWORDS: LEAST-COST ALTERNATIVES POLICIES PRODUCTION-COSTS PRICES POLLUTANTS COMPARATIVE-ADVANTAGE POLLUTION-ABATEMENT ECONOMICS POLLUTION PESTICIDES SEDIMENTATION PLANT-NUTRIENTS PRODUCTION-EFFICIENCY WATER-POLLUTION SOIL-POLLUTION

0043994
AGENCY: ARS 3502
PERIOD: 23 AUG 77 TO 23 AUG 82
INVEST: LARSON W E; HOLT R F; ONSTAD C A
PROJECT#: 3502-20750-003
PERF ORG: USDA-ARS SOIL & WATER RESEARCH
RM201 SOIL SCIENCE BLDG
LOCATION: UNIV OF MINNESOTA
ST PAUL MIN

ENVIRONMENTAL CONSEQUENCES OF REMOVAL OF CROP RESIDUES

OBJECTIVES: Determine the environmental impact of removing crop residue from the land for the major Land Resource Areas of the United States.

APPROACH: Crop residue production will be computed. Water and wind erosion, water runoff, and nutrient removal will be calculated for five tillage-residue management systems. Crop production data will be obtained from Agricultural Statistics. The Universal Soil Loss Equation, the Wind Erosion Equation, and the SCS runoff procedure will be used. Areas where crop residues can be safely removed will be determined.

KEYWORDS: MANAGEMENT SOIL-EROSION SOIL-LOSS WATER WIND-EROSION EROSION ENVIRONMENTAL-IMPACT CROP-RESIDUES SOIL-MANAGEMENT NUTRIENT-REMOVAL RUNOFF TILLAGE EROSION-CONTROL

0071859
AGENCY: CSRS MIN
PERIOD: 01 DEC 76 TO 30 JUN 82
INVEST: SCHULER R T; BLAKE G R; CROOKSTON R K
PROJECT#: MIN-12-028
PERF ORG: AGRI ENGINEERING
LOCATION: UNIV OF MINNESOTA
ST PAUL MIN

REDUCED TILLAGE STUDIES EMPHASIZING ENERGY, SOIL, AND WATER CONSERVATION ON A SANDY LOAM SOIL

OBJECTIVES: To develop reduced tillage practices with low energy requirements, erosion control, moisture conservation and maximum yield. Reduced tillage systems will be compared to conventional methods. Special emphasis will be placed on corn, soybeans and potato production on sandy loam soils.

APPROACH: Four tillage treatments with five cropping systems will be established. All test plots will be irrigated and chemical weed control will be utilized. Data on energy use, water consumption, soil water levels, temperature and yield will be collected. Susceptibility to wind erosion will be evaluated.

KEYWORDS: #EMP #EMR EROSION-CONTROL CROP-YIELDS SANDY-LOAM-SOILS CROPPING-SYSTEMS HERBICIDES SOIL-WATER TEMPERATURE ENERGY-REQUIREMENTS NON-TILLAGE IRRIGATION CONSERVATION TILLAGE WATER-CONSERVATION MINIMUM-TILLAGE SOIL-CONSERVATION ENERGY-CONSERVATION REDUCED-TILLAGE SOYBEANS CORN EROSION ENERGY POTATOES

PROGRESS:77/01 77/12
The cropping systems and tillage treatments have been established at the Becker Experiment Farm. Data were collected from field plots and analyzed but may not be meaningful as all plots had been fall plowed and seeded to winter rye. Data collected were yield (potatoes, corn, and soybeans), plant population (corn and soybeans) and early plant growth (corn). The yield for the two potato varieties (Norland and Russet Burbank) and the soybeans was not affected significantly by tillage treatments. Tillage did affect corn yield at the 90% significance level where the chisel treatment yield was higher than the other tillage treatments of moldboard plow, till plant and no till. Equipment and instrumentation were obtained or fabricated which will be used to evaluate the energy requirement of the field operations.

PUBLICATIONS:77/01 77/12
NO PUBLICATIONS REPORTED THIS PERIOD.

0066720
AGENCY: SAES NY.C
PERIOD: 01 OCT 74 TO 30 SEP 79
INVEST: HAITH D A
PROJECT#: NYC-123325
PERF ORG: AGRI ENGINEERING
LOCATION: CORNELL UNIV
ITHACA NY

LAND USE AND WATER QUALITY

OBJECTIVES: Methods will be developed to estimate the magnitudes of nonpoint sources of nitrogen and phosphorus in runoff waters from agricultural and rural land. Control measures will be evaluated for effectiveness and costs.

APPROACH: A linear programming model will be used to determine cost-effective management plans. The general approach will rely on existing and readily available data and will be suitable for use in regional water quality and land management planning. Particular attention will be given to crop selection and management practices, suitable to New York, which can reduce runoff and improve runoff quality. The use of buffer areas along waterways to filter nutrients from runoff will be investigated. The project will utilize data from previous and ongoing studies. No field experimental work will be undertaken. Data requirements for implementation of the approach in any given study are land use, soils and topographic maps and agricultural census and daily precipitation summaries.

KEYWORDS: BUFFERS ENGINEERING SOILS TOPOGRAPHY PRECIPITATION RUNOFF COSTS LINEAR-PROGRAMMING LAND-MANAGEMENT WATER-POLLUTION MODELS WATER-QUALITY PLANNING NITROGEN PHOSPHORUS LAND-USE

PROGRESS:77/01 77/12
The accuracy of a simple loading function approach to estimating nutrient losses from agricultural land in rainfall and snowmelt runoff has been tested using water quality data from a 330 km. watershed. A continuous simulation model has been developed to predict losses of nitrogen and phosphorus in cropland runoff and percolation. The model does not require calibration and has been validated using data from monitored field plots.

PUBLICATIONS:77/01 77/12
TUBBS, L. J. and HAITH, D. A. 1977. Simulation of nutrient losses from cropland. Amer. Soc. of Agr. Engineers, Paper No. 77-2502.

0074954
AGENCY: CSRS ILLU
PERIOD: 01 APR 78 TO 30 SEP 79
INVEST: SCOTT J T JR
PROJECT#: ILLU-05-0320
PERF ORG: AGRI ECONOMICS
LOCATION: UNIV OF ILLINOIS
URBANA ILL

ECONOMIC FEASIBLITY OF SUPPLEMENTAL IRRIGATION IN SOUTHERN ILLINOIS

OBJECTIVES: Collect and project a set of physical and economic data for on-farm rain-fall catchment reservoirs and supplemental irrigation costs based on a probability sample locations in the claypan soils in southern Illinois. Collect yield data on corn and soybeans and rainfall pattern data and project yields for adequate water availability. Estimate potential reduction in pollutants into streams with a system of catchment reservoirs for water reuse. Evaluate the reduction of risk when adequate water is available for crop production. Estimate aggregate supply response and stability at different levels of water availability and prices and the benefit to society as a whole.

APPROACH: The proposed study will be conducted in four phases: Survey and estimation of the potential for rainfall catchment reserviors, estimation of potential yields with supplemental irrigation, estimation of potential costs and returns of supplemental irrigation, estimation reduction of non-point-source pollution, use of a quadratic programming model to estimate grain supply with risk assessment of irrigation investment vs. natural rainfall.

KEYWORDS: IRRIGATION SUPPLY-RESPONSE WATER RUNOFF ECONOMICS ECONOMIC-FEASIBILITY CATCHMENT WATER-REUSE CORN SOYBEANS CROP-YIELDS COSTS-RETURNS WATER-POLLUTION MODELS RISK GRAIN RESERVOIRS

PROGRESS:78/01 78/12
From preliminary work in fitting available yield data to already published prediction models, it appears that experimental yields obtained with irrigation are substantially greater than those which would be predicted from the model. However, even with the limited amount of economic data available at this time, it appears that supplemental irrigation on corn in southern illinois is economically feasible where water is available. Other achievements listed under this project include cost analysis of corn production and development and testing of relevant statistical models.

PUBLICATIONS:78/01 78/12
CHOW, A. Y. AND J. T. SCOTT., JR. 1978. A computer program for factor analysis regression. Univ. Ill. Agr. Exp. Sta. Dept. of Agr. Econ. Res. Rpt. 159. 12p.
SCOTT, J. T., JR. AND A. FLEISHMAN. 1978. Statistical goodness of classical factor analysis regression (CRAR). Univ. Ill. Coll. Agr. Agr. Exp. Sta. 759. 31p.

0074641
AGENCY: CSRS NY.C
PERIOD: 01 MAR 78 TO 31 JAN 81
INVEST: STEENHUIS T S; MUCK R
PROJECT#: NYC-123424
PERF ORG: AGRI ENGINEERING
LOCATION: CORNELL UNIV
ITHACA NY

FATE OF WATER AND MAJOR PLANT NUTRIENTS FROM MARGINAL AGRICULTURAL LAND

OBJECTIVES: Minimize adverse impact of water quality of bringing marginal land into agricultural production, and develop and verify a model that predicts the effect of best management practices on water and on pollutant losses.

APPROACH: On four plots of 100 meter length and hard pan at 30 cm depth, various management practices will be installed. Surface and subsurface runoff will be measured and tested for nitrogen and phosphorus.

KEYWORDS: SURFACE-WATER SUBSURFACE NUTRIENT-LOSSES MARGINAL-LAND WATER-QUALITY POLLUTION WATER RANGES FARM-LAND NUTRIENTS AGRICULTURAL-PRODUCTION NITROGEN RUNOFF MANAGEMENT MODELS PHOSPHORUS

0040644
AGENCY: ARS 3505
PERIOD: 02 NOV 73 TO 02 NOV 79
INVEST: YOUNG R A; ONSTAD C A
PROJECT#: 3505-20790-001
PERF ORG: USDA-ARS POLLUTION &EROSION RE
S
LOCATION: NC SOIL CONSERVATION RES LAB
MORRIS MIN

FIELD DETERMINATION OF NUTRIENTS AND SEDIMENT FROM NON-POINT SOURCES

OBJECTIVES: Assess the impact of man on nutrient enrichment of lakes and streams. Develop hydrologic and nutrient budget for agricultural and nonagricultural watersheds. Relate water quality and sediment yield to watershed land use practices. Model agricultural chemical transport.

APPROACH: Locate and map watersheds one square mile or less that contain agricultural, nonagricultural, and urban land use practices. Obtain soil surveys, from plans, animal, cropping, and other use practices, and environmental parameters. Hydrological, soil, and water quality will be monitored at points of cultural, geological, and topographic discontinuities.

KEYWORDS: EUTROPHICATION LAKES STREAMS POLLUTION WATER-POLLUTION WATER-RESOURCES WATER NUTRIENT-CYCLE HYDROLOGIC-BUDGET WATER-QUALITY SEDIMENT-YIELD LAND-USE MODELS SOIL-SURVEYS NUTRIENTS SEDIMENTS RUNOFF WATERSHEDS

PROGRESS:77/01 77/12
The forested watershed was closed out in the spring of 1977 after three years of data accumulation. Watershed monitoring and data collection continued on the agricultrual watershed, although, due to extremely dry conditions going into 1977, there was almost no snowmelt runoff and rainfall from only three rainfall events. Data analysis from both watersheds is underway and will be used to develop water and nutrient budgets for the watersheds, relate water quality and sediment yield to land use practices, and to provide test data for watershed modeling.

PUBLICATIONS:77/01 77/12
NO PUBLICATIONS REPORTED THIS PERIOD.

0068255
AGENCY: CSRS OHO
PERIOD: 01 JUL 75 TO 30 SEP 79
INVEST: FORSTER D L
PROJECT#: OHO00539
PERF ORG: AGRI ECONOMICS & RURAL SOCIOL
LOCATION: OHIO AGRICULTURAL R AND D CENTER
COLUMBUS OHO

ECONOMIC ANALYSIS OF THE CONTROL OF WATER POLLUTION IN AGRICULTURAL PRODUCTION

OBJECTIVES: Investigate alternative methods of disposing municipal and feedlot waste on agricultural land, determine economic optimum allocation of resources for the disposal of feedlot and municipal wastes on agricultural lands, evaluate alternative policy mechanisms to be used in the control of water pollution from feedlot and municipal waste disposal.

APPROACH: Identify and evaluate the cost structure of disposal technologies and identify the effects of the disposal technologies on the characteristics of waste. Identify the input/output relationship between waste and crop production. Determine economic optimum waste disposal systems and rates of application for farmers and municipalities.\ Evaluate alternative mechanisms to control water pollution from animal and municipal wastes.

KEYWORDS: COSTS CROP-PRODUCTION INPUT-OUTPUT-ANALYSIS POLICIES LAND-DISPOSAL APPLICATION-RATE RESOURCE-ALLOCATION ANIMAL-WASTE MUNICIPAL-WASTE WASTE-DISPOSAL WATER-POLLUTION MANURES ALTERNATIVES FARM-MANAGEMENT SLUDGE ECONOMICS

PROGRESS:78/01 78/12
The focus of this research is on three separate areas: livestock waste disposal, landspreading sewage sludge, and non-point pollution control. In the livestock waste disposal area, work was completed which describes and analyzes alternative systems used to handle waste from livestock facilities. Some of the conclusions from the study are, a) substantial economies of size are present for nearly all waste disposal systems; b) waste management costa are substantial to producers and vary widely between waste disposal systems; c) waste is a source of plant nutrients and benefits from these nutrients accrue to the producer; and d) a large number of waste management technologies are available to control water pollution and odor; thus, design standards to meet environmental goals are impractical. The second area of study, landspreading of sewage sludge, focuses primarily on a four city sludge landspreading demonstration project. This demonstration porject is a multi-disciplinary effort aimed at demonstrating acceptable management systems in landspreading sewage sludge. A computer algorithm is available to recommend appropriate sludge application rates for individual farmers and to value the benefits of sludge for these farmers. The third area of research, non-point pollution control, is concerned with the economic impacts of reducing soil loss in the Lake Erie Basin. One study investigates the effects of reducing soil loss in the Honey Creek Watershed.

PUBLICATIONS:78/01 78/12
FORSTER, D.L. and BECKER, G.S. 1979. Costs and Income affects of alternative erosion control strategies: The Honey Creek Watershed. North Central Journal of Agricultural Economics 1:53-60.
OTT, S. and FORSTER, D.L. 1978. Landspreading an alternative for sludge disposal. American Journal of Agricultural Economics 60:555-558.
FORSTER, D.L. 1978. Economic comparisons of alternative waste management systems for swine and dairy. American Dairy Science Association annual meetings. East Lansing, Michigan.
FORSTER, D.L. 1978. Economic impacts of changing tillage practices in the Lake Erie Basin. Technical Report Series. U.S. Army Engineer District, Buffalo, N.Y.
FORSTER, D.L. 1978. Higher energy prices, where are they leading agriculture.
Ohio Soil and Water Conservation Districts annual meetings, Columbus, Ohio.

0071887
AGENCY: SAES NY.C
PERIOD: 25 OCT 76 TO 30 SEP 79
INVEST: WALTER M E; STEENHUIS T S; LOEHR
PROJECT#: NYC-123379
PERF ORG: AGRI ENGINEERING
LOCATION: CORNELL UNIV
ITHACA NY

EFFECTIVENESS OF SOIL AND WATER CONSERVATION PRACTICES FOR POLLUTION CONTROL

OBJECTIVES: Evaluate the impacts of soil and water conservation practices (SWCP) on nonpoint source pollution from non-irrigated cropland agriculture in the Eastern U.S. Evaluate the cost-effectiveness of SWCP in preventing or reducing nonpoint source water pollution. Assess the indirect environmental impacts and costs of implementing SWCP.

APPROACH: First develop a general methodology for estmating the environmental or economic parameters of interest. The second step is to apply the methodologies to examples or cases of interest, using available data from previous and on-going studies. The basic unit of analysis will be a soil/cover complex; i.e., a field-size plot with homogeneous soil and plant cover characteristics. Pollutant losses will thus be "edge-of-field" and cost analyses will be partial rather than full farm or regional budgets. Project Phasing: Phase I - development of the technical information (pollutant losses, costs, etc.) and methods needed to evaluate the effectiveness of SWCP in controlling nonpoint source pollution form soil/cover complexes. Phase II - cost-effectiveness of SWCP. This will include systematic evaluation of combinations of SWCP, pollutant transport and indirect impacts.

KEYWORDS: ESTIMATES ECONOMICS METHODOLOGY ENVIRONMENTAL-IMPACT EVALUATION TRANSPORT ENGINEERING COST-EFFECTIVENESS COSTS WATER-CONSERVATION IMPACT NON-POINT-POLLUTION CONSERVATION POLLUTION PLANNING WATER-QUALITY WATER-POLLUTION SOIL-CONSERVATION

PROGRESS:77/01 77/12
Preliminary analyses had indicated that soil and water conservation practices can be effective means of controlling water pollution associated with sediment and pollutants which are strongly adsorbed to sediment (e.g., DDT). The practices may be considerably less effective in controlling pollution due to dissolved chemicals (nitrates) or moderately adsorbed chemicals (most pesticides currently in use). Cost analyses indicate that except for terracing and sod-based rotations, most soil and water conservation practices are not likely to significantly increase former costs.

PUBLICATIONS:77/01 77/12
WALTER, M. F., STEENHUIS, T.S., and HAITH, D. A. 1977. Soil and water conservation practices for pollution control. Amer. Soc. of Agr. Engineers Paper No. 77-2506.

0043388
AGENCY: ARS 3305
PERIOD: 12 OCT 76 TO 12 OCT 81
INVEST: OWEN L B; EDWARDS W M
PROJECT#: 3305-20790-001
PERF ORG: USDA-ARS N APPALACHIAN EXP
LOCATION: WATERSHED RESEARCH
COSHOCTON OHO

RELATION OF AGRICULTURAL PRACTICE TO WATER QUALITY IN NORTH APPALACHIAN REGION

OBJECTIVES: Better define the significance of fertilizer & pesticide treatments associated with beef-cattle production on downstream water quality.

APPROACH: Measure concentrations of plant nutrients & pesticide residues in samples of soil, plants, runoff, sediments, & spring waters & relate to chemical management treatments. Treat pasture watersheds with different rates of nitrogen fertilizer, grass species & gazing concentrations, plus alternate winter occupancy. Relate runoff amount & quality to antecedent soil moisture, surface roughness, soil compaction, rainfall & cattle management. Evaluate persistence & runoff transport of herbicides & insecticides protecting corn & meadow crops, following surface application on watersheds & lysimeters. Use findings to develop & refine hydro-chemical models.

KEYWORDS: ANIMAL-WASTE NON-POINT-POLLUTION GRAZING PASTURES MODELS TRANSPORT WATER-QUALITY PHOSPHORUS NITROGEN GROUNDWATER SURFACE-WATER INSECTICIDES PESTICIDES WATERSHEDS WATER POLLUTION SEDIMENTS WATER-POLLUTION FERTILIZERS RUNOFF WATERSHED-MANAGEMENT EUTROPHICATION

PROGRESS:77/01 77/12
The pathway and amount of chemicals transported from watersheds were affected by different pasture feeding systems. For the pasture used for winter feeding, significant chemical sediment transport occurred over the surface flow, but the chemical concentrations did not exceed water quality standards. Little impairment to water quality occurred on the pastures used only for summer grazing. The persistence of prominent herbicides were studied under field conditions. Atrazine and simazine under conventional and no-tillage management, degraded through 3 or 4 half-lines during the 160-day growing season. Degradation rates were consistently high during the warm months and slowed markedly under cool, fall temperatures. Under similar soil pH conditions, there was no consistent effect of surface mulch on the herbicide degradation rate. On 0.4 to 3.5 ha agricultural watersheds, highest concentrations of atrazine (0.48 ppm) and simazine (1.2 ppm) were present in runoff occurring soon after application and declined rapidly for later events. A maximum of 6% and an average of about 2% of the applied herbicides were transported in the runoff. Less runoff and herbicide loss occurred from no-tillage than from conventionally-tilled corn. Herbicide concentration in runoff was predicted from data on days after application and a tillage times application rate. Proper management of herbicide use requires such information on probable transport in runoff.

PUBLICATIONS:77/01 77/12

CHICHESTER, F.W. 1977. Effects of increased fertilizer rates on nitrogen content of runoff and percolate from monolith lysimeters. Journal of Environmental Quality 6(2):211-217.

OWENS, L.B., NELSON, D.W. and SOMMERS, L.E. 1977. Determination of inorganic phosphorus in oxalate extracts of soils. Soil Sci. Soc. Am. J. Vol. 41, No. 1, Jan.-Feb.

0043423
AGENCY: ARS 3305
PERIOD: 12 OCT 76 TO 12 OCT 79
INVEST: EDWARDS W M
PROJECT#: 3305-20790-002
PERF ORG: USDA-ARS N APPALACHIAN EXP
LOCATION: WATERSHED RESEARCH
COSHOCTON OHO

MANAGEMENT OF WASTES AND WASTE WATERS FROM SMALL FEEDLOTS

OBJECTIVES: Determine the amounts and concentrations of animal wastes in runoff from small cattle-confinement operations typical of the Eastern U.S. Evaluate effects on downstream water quality from runoff management systems below the lots & from manure spreading.

APPROACH: Evaluate runoff quality from a 30-cow herd wintered on a high-roughage ration in an unpaved barnlot & from a 50-steer fattening operation in a paved feedlot. Study effects of lot management & runoff management treatments below the lots. Measure & sample runoff immediately below: Lots, settling basins, different lengths of grassed waterways & small watersheds where manure is applied. Relate nutrient transport to management practices & use results plus long-term hydrologic records to improve water-quality models.

KEYWORDS: BARNYARDS MODELS HYDROLOGY NUTRIENT-TRANSPORT CONFINEMENT WASTE-WATER CATTLE MANURES WASTE-MANAGEMENT WATER-QUALITY SURFACE-WATER ANIMAL-WASTE WATERSHEDS WATER FEEDLOTS WATER-POLLUTION RUNOFF

PROGRESS:77/01 77/12
Construction was completed on feedlot (2050 sq. ft.) with addition of a concrete manure push-off; on settling basin (300 ft.), including a semi-automatic gate for release of feedlot effluent after settling of solids; and on two grass filter strips (15' x 100'). Each of these four units were instrumented for measuring and sampling runoff. Sampling and analysis has begun. The parameters initially being measured are: total solids, total N. NO(3). -N, NH(4).. -N, soluble (ortho) P, total P, soluble K, COD, Total C, inorganic C, and BOD.

PUBLICATIONS:77/01 77/12
NO PUBLICATIONS REPORTED THIS PERIOD.

0043733
AGENCY: ARS 3505
PERIOD: 03 MAY 77 TO 03 MAY 82
INVEST: YOUNG R A; HOLT R F
PROJECT#: 3505-20790-006
PERF ORG: USDA-ARS POLLUTION &EROSION RE
S
LOCATION: NC SOIL CONSERVATION RES LAB
MORRIS MIN

EFFECT OF ANIMAL WASTE MANAGEMENT SYSTEMS ON RUNOFF, EROSION, AND WATER

OBJECTIVES: Determine the effect of various animal waste management systems on quality and quantity of surface runoff and soil loss. Evaluate the ability of various land and cropping treatments to absorb and retain pollutants in runoff from livestock feedlots. Evaluate the effectiveness of these land treatments in controlling the discharge of pollutants from a livestock feedlot under spring snow melt conditions.

APPROACH: Use simulated and natural rainfall to induce runoff and erosion on standard runoff plots and four small watersheds 2 to 4 acres in size. Both runoff plots and watersheds will be fully instrumented to measure and sample soil and water losses. Systems to be tested will be disposal of manure on frozen ground at different times during the winter, different rates of manure application, and various cropping treatments below feedlots to absorb and retain pollutants in runoff.

KEYWORDS: CONTROL MANAGEMENT CROPPING-SYSTEMS ABSORPTION WINTER WASTE-DISPOSAL LAND-APPLICATION MEASUREMENT RAINFALL SOIL-LOSS SOILS POLLUTION FEEDLOTS EROSION RUNOFF WASTE-MANAGEMENT WATER-QUALITY MANURES ANIMAL-WASTE

PROGRESS:77/01 77/12
Due to extremely dry soil conditions going into 1977, there was very little snowmelt runoff from plots to which 0.33", 0.7', and 1.1" of dairy manure had been applied in midwinter. Relative amounts of runoff, however, were the same as in the two previous years with the check plot having the greatest runoff and the two heaviest manure applications having the least. Four small watersheds, 2 to 4 acres in size, were treated with the same manure applications in midwinter as the runoff plots. Again, the lest amount of runoff from snowmelt or summer rainfall was from the 2 acres with the highest manure applications. Three different cropping treatments were tested under simulated rainfall to determine their ability to absorb and retain pollutants in runoff. Runoff and sediment were reduced 80% and 93%, respectively, by passing from the feedlot through 90 feet of vegetated buffer strip. TN and TP were reduced 70% and 73%, respectively. There was also of a significant reduction in the movement of coliform organisms in the feedlot as it passed through the vegetated buffer strips.

PUBLICATIONS:77/01 77/12

YOUNG, R. A. AND R. F. HOLT. Effect of winter applied manure on annual runoff, erosion, and nutrient movement. Jour. Soil and Water Conserv. 32 (1977):219-222.

0068692
AGENCY: CSRS OHO
PERIOD: 01 JUL 75 TO 30 JUN 80
INVEST: VAN KEUREN R W; OWENS L B; WHITE
PROJECT#: OHO00545
PERF ORG: AGRONOMY
LOCATION: OHIO AGRIC RES AND DEVLP CENTER
WOOSTER OHO

WATER QUALITY AFFECTED BY CROP CULTURE AND ANIMAL OCCUPANCY

OBJECTIVES: Determine pretreatment levels of N, P, K, Cl, pesticides, sediment BOD, COD, TVS, TOC from watersheds. Determine post-treatment levels of some materials from summer and winter pastures, barnlots, and cropped watersheds. Compare the effectivenes of pasture management systems, barnlot runoff handling systems and cropping systems for maintenance of water quality.

APPROACH: Instrumented watersheds will be used to measure and sample runoff and ground water from beef cattle pastures, barnlots, and cropping systems. Water samples will be analyzed as appropriate to determine water quality.

KEYWORDS: QUALITY-MAINTENANCE WATER GROUNDWATER CROPPING-SYSTEMS PASTURES RUNOFF OXYGEN-DEMAND WATER-POLLUTION WATERSHEDS WATER-QUALITY ANIMAL-WASTE NITROGEN PHOSPHORUS PASTURE-MANAGEMENT POTASSIUM CHLORINE PESTICIDES

PROGRESS:78/01 78/12
Small watersheds (.25 to 3 ha) were used in a summer grazing (May-Nov.) and winter feeding (Nov.-May) program for beef cows. The levels of N fertilization used were 56 and 224 kg/ha/yr. Water flow measurements were made for each watershed and chemical analyses were performed on precipitation, surface runoff and sediment, and subsurface water samples. Data from the 1974-77 study period show N and P losses ranging from 16 to 34 kg/ha/yr and 0.5 to 2.6 kg/ha/yr, respectively. Approximately 80% of the N and 67% of the P was lost during the November through April period. These preliminary results indicate that N and P losses were negligible during the summer grazing period. During the winter feeding period when cattle were concentrated in a smaller area and for longer periods and when there was little or no vegetative growth, N and P losses were higher, with P losses much smaller than N losses. N was lost in water running off the surface and in water than filtered through the soil (subsurface flow). When the greatest losses occurred, most of the nutrients lost came off in the surface water, but at these times, soil erosion was almost nonexistent. It appears that cattle grazing managed pastures are not contributing significantly to surface or ground water pollution.

PUBLICATIONS:78/01 78/12
OWENS, L.B. and VAN KEUREN, R.W. 1978. Water quality aspects of medium and high fertility small pastured watersheds. Amer. Soc. Agron. Abst.:33. Chicago, IL, Dec. 3-8, 1978.

0068970
AGENCY: CSRS WIS
PERIOD: 30 SEP 75 TO 30 SEP 79
INVEST: DANIEL T C; PETERSON J O; POWELL R D
PROJECT#: WIS05112
PERF ORG: SOIL SCIENCE
LOCATION: UNIV OF WISCONSIN
MADISON WIS

DEVELOPMENT AND DEMONSTRATION OF METHODOLOGY FOR THE CONTROL OF BARNYARD EFFLUENT

OBJECTIVES: Develop and demonstrate on selected soil types cost-effective methodology for controlling nutrients and sediment in runoff water from barnyards, rest areas and feedlots associated with 40 to 100 cow dairy operations.

APPROACH: Study involves research and extension personnel from the University as well as representatives of the state regulatory agency (DNR) and the Federal agency responsible for assisting farmers with conservation practices (ASCS/USDA). Local farmers, county Extension and SCS-ASCS personnel will also participate. Monitoring will quantify water, nutrient and sediment movement before and after control methodology is designed and installed to assess the effectiveness of the control measures. Laboratory analyses will be made to determine species of nitrogen, phosphorus, chlorides, electrical conductivity, oxidant demand and residue. Cost/benefit analyses will weigh the effectiveness of the abatement methodology vis-a-vis improvements in water quality and economic effects on farmers.

KEYWORDS: ELECTRICAL-CONDUCTIVITY ECONOMICS SOIL-TYPES OXIDANTS NITROGEN CHLORIDES POLLUTION-ABATEMENT PHOSPHORUS SEDIMENTS RUNOFF DAIRY-CATTLE WATER-QUALITY NUTRIENTS FEEDLOTS ANIMAL-WASTE WATER-POLLUTION COST-BENEFIT-ANALYSIS MONITORING METHODOLOGY EFFLUENTS

PROGRESS:76/01 76/12
The Barnyard Effluent Project was set up to evaluate the effectiveness of various management techniques for reducing the outflow of sediments and nutrients from barnyards and feedlots commonly associated with Wisconsin dairy operations. During spring runoff samples were collected from the five monitoring sites which had been established in the Fall of 1975. Generally speaking, rainfall ceased statewide after the 16th of May so only a very few samples were collected during the summer and fall months. It was determined by project personnel that because of the lack of good background data (due to the lack of rainfall) that all sites would be maintained as untreated through the Spring of 1977 at which time management practices would be installed. Management plans were developed for each barnyard site. In the Fall of 1976 an additional site was added on coarse sandy soils in Waupaca County in accordance with the project plan.

PUBLICATIONS:76/01 76/12
NO PUBLICATIONS REPORTED THIS PERIOD.

0069209
AGENCY: SAES MICL
PERIOD: 02 SEP 75 TO 01 SEP 80
INVEST: LOUDON T L
PROJECT#: MICL03142
PERF ORG: AGRI ENGINEERING
LOCATION: MICHIGAN STATE UNIV
EAST LANSING MIC

LAND APPLICATION OF ANIMAL WASTE

OBJECTIVES: Apply animal wastes of known composition to agricultural soils. Evaluate crop response to waste applied in various quantities and at various times. Identify satisfactory methods of applying liquid waste to growing crops through irrigation systems. Identify practices which will minimize water pollution resulting from application of animal waste to frozen soil.

APPROACH: Liquid swine and dairy waste are analyzed for nutrient content and applied to growing crops through irrigation systems with application rate, amount and distribution measured. Crop response is monitored by visual observations and final yield. Various types of irrigation equipment are being tried. Plots 400 ft.^{2} in area receive bedded dairy manure during winter months. Various soil surface conditions are included. Runoff is monitored quantitatively and qualitatively at intervals down 3-5% slopes for up to 200 ft.

KEYWORDS: MANURE LAND-APPLICATION WATER-POLLUTION RUNOFF IRRIGATION ANIMAL-WASTE WASTE-DISPOSAL SOILS WASTE-UTILIZATION LIQUID-MANURES LIQUID-WASTE WINTER FROZEN-SOILS NUTRIENT-CONTENT APPLICATION-RATE NUTRIENT-LOSSES CROP-RESPONSE PLANT-RESPONSE

PROGRESS:77/01 77/12
Field plot runoff from manured and control areas was sampled for three different plot surface conditions during snowmelt and spring rainfall events. Runoff was collected at two locations downslope from the manured area. Twelve meters downslope from the manured area, water quality data show a high reduction in nutrient concentration. Runoff collected 34 meters downslope was comparable to control-plot quality. For grass, the data indicates that soluble nitrogen and phosphorus forms are removed more readily from runoff than materials which contribute to COD. This is also true for corn stubble plot surfaces. Variation in concentrations among the different surface conditions was generally small and statistically insignificant at sampling locations 34 meters down slope from the area receiving the manure application; however, significant differences in ammonia and COD were noted within the manured area for different surface conditions. Compared with other surface conditions, a shorter buffer length of disked corn stubble was required to reduce all nutrient parameters to background levels. There was no significant difference in background runoff quality among control plots of the three surface conditions. The project has been expanded to look at the influence of buffer area associated with field scale livestock waste spreading. This type of information is needed for non-point pollution control planning.

PUBLICATIONS:77/01 77/12
THOMPSON, D.R. (1977). Nutrient Movement During Winter Runoff from Manure Treated Plots, unpublished M.S. Thesis, Agricultural Engineering Department, Michigan State University.

0068255
AGENCY: CSRS OHO
PERIOD: 01 JUL 75 TO 30 SEP 79
INVEST: FORSTER D L
PROJECT#: OHO00539
PERF ORG: AGRI ECONOMICS & RURAL SOCIOL
LOCATION: OHIO AGRICULTURAL R AND D CENTER
COLUMBUS OHO

ECONOMIC ANALYSIS OF THE CONTROL OF WATER POLLUTION IN AGRICULTURAL PRODUCTION

OBJECTIVES: Investigate alternative methods of disposing municipal and feedlot waste on agricultural land, determine economic optimum allocation of resources for the disposal of feedlot and municipal wastes on agricultural lands, evaluate alternative policy mechanisms to be used in the control of water pollution from feedlot and municipal waste disposal.

APPROACH: Identify and evaluate the cost structure of disposal technologies and identify the effects of the disposal technologies on the characteristics of waste. Identify the input/output relationship between waste and crop production. Determine economic optimum waste disposal systems and rates of application for farmers and municipalities. Evaluate alternative mechanisms to control water pollution from animal and municipal wastes.

KEYWORDS: COSTS CROP-PRODUCTION INPUT-OUTPUT-ANALYSIS POLICIES LAND-DISPOSAL APPLICATION-RATE RESOURCE-ALLOCATION ANIMAL-WASTE MUNICIPAL-WASTE WASTE-DISPOSAL WATER-POLLUTION MANURES ALTERNATIVES FARM-MANAGEMENT SLUDGE ECONOMICS

PROGRESS:78/01 78/12
The focus of this research is on three separate areas: livestock waste disposal, landspreading sewage sludge, and non-point pollution control. In the livestock waste disposal area, work was completed which describes and analyzes alternative systems used to handle waste from livestock facilities. Some of the conclusions from the study are, a) substantial economies of size are present for nearly all waste disposal systems; b) waste management costa are substantial to producers and vary widely between waste disposal systems; c) waste is a source of plant nutrients and benefits from these nutrients accrue to the producer; and d) a large number of waste management technologies are available to control water pollution and odor; thus, design standards to meet environmental goals are impractical. The second area of study, landspreading of sewage sludge, focuses primarily on a four city sludge landspreading demonstration project. This demonstration porject is a multi-disciplinary effort aimed at demonstrating acceptable management systems in landspreading sewage sludge. A computer algorithm is available to recommend appropriate sludge application rates for individual farmers and to value the benefits of sludge for these farmers. The third area of research, non-point pollution control, is concerned with the economic impacts of reducing soil loss in the Lake Erie Basin. One study investigates the effects of reducing soil loss in the Honey Creek Watershed.

PUBLICATIONS:78/01 78/12
FORSTER, D.L. and BECKER, G.S. 1979. Costs and income affects of alternative erosion control strategies: The Honey Creek Watershed. North Central Journal of Agricultural Economics 1:53-60.
OTT, S. and FORSTER, D.L. 1978. Landsprading an alternative for sludge disposal. American Journal of Agricultural Economics 60:555-558.
FORSTER, D.L. 1978. Economic comparisons of alternative waste management systems for swine and dairy. American Dairy Science Association annual meetings. East Lansing, Michigan.
FORSTER, D.L. 1978. Economic impacts of changing tillage practices in the Lake Erie Basin. Technical Report Series. U.S. Army Engineer District, Buffalo, N.Y.
FORSTER, D.L. 1978. Higher energy prices, where are they leading agriculture.
Ohio Soil and Water Conservation Districts annual meetings, Columbus, Ohio.

0065448
AGENCY: CSRS WIS
PERIOD: 01 OCT 78 TO 30 SEP 81
INVEST: BUBENZER G D
PROJECT#: WIS05090
PERF ORG: AGRI ENGINEERING
LOCATION: UNIV OF WISCONSIN
MADISON WIS

SEDIMENT SOURCE AREA DETERMINATION USING CESIUM 137

OBJECTIVES: Investigate the mechanics of the Cesium 137-sediment erosion process in order to predict mure reliably erosin rates from Cesium 137 observations. Develop sediment balances for small watersheds using Cesium 137 levels.

APPROACH: Tilled and untilled plots will be established to study the mechanics of the Cesium 137-sediment transport process. Rill patterns will be imposed on a portion of the plots. Sediment and Cesium loss will be determined for the two tillage conditions and type of erosion pattern developed on the plots Cesium 137 and sediment balances will be developed for seven small agricultural watersheds. Sediment yield estimates will be made for each of the watersheds based upon the loss of cesium 137. The estimated sediment yields will be compared with the sediment trapped in the farm ponds at the outlets of the watersheds.

KEYWORDS: WATERSHEDS SEDIMENTS SEDIMENT-YIELD SOIL-EROSION RUNUFF CESIUM SOIL-LOSS MECHANICS EROSION SEDIMENT-TRANSPORT TILLAGE SEDIMENT-TRAPS RADIOISOTOPES

PROGRESS:77/01 77/12
The movement of sediments on an agricultural watershed in north central Wisconsin is being monitored using Cesium-137 as an indicator of erosion and deposition. a Cesium-137 balance has been established for the watershed based upon measured concentration levels and land use patterns. soil Cesium-137 levels were marsh greater than forest greater than pasture greater than cultivated land. Excluding natural decay, it is estimated that 94% of the Cesium-137 deposited on the watershed is still within the watershed. cesium-137 levels in the marsh indicate that the marsh is acting as a filter and deposition area which prevents fine sediments from reaching the lake. There is little evidence of a buildup of Cesium-137 in the lake. Within the cultivated area, Cesium-137 levels indicate soil loss depths ranging from 9.8 cm on a 4.3% - 71 m slope to 2.1 cm on a 0.1% - 95 m solope over approximately 20 years since the fallout occurred. Deposition depths as great as 16 cm have been observed at the base of slopes where the outlet for surface runoff was restricted. Five additional small watershed sin southwestern Wisconsin have been selected for Cesium-137 analysis. All watersheds drain into farm ponds with very high trap efficiencies. Cesium-137 samples have been collected from the watersheds and ponds ana are currently being analyzed. Erosion rates and sediment yields will be correlated to land use.

PUBLICATIONS:77/01 77/12
MCHENRY, J.R. and RITCHIE, J.C. 1977. Estimating field erosion losses from fallout Cesium-137 measurements. Proc. of Sym. Sedimentation of Inland Waters. Int. Assoc. of Sci. Hydr. Paris, France.

0060362
AGENCY: CSRS IND
PERIOD: 01 JUL 71 TO 30 SEP 81
INVEST: WHEATON R Z
PROJECT#: IND046029
PERF ORG: AGRI ENGINEERING
LOCATION: PURDUE UNIV
LAFAYETTE IND

WATER MANAGEMENT IN A RURAL-URBAN COMMUNITY

OBJECTIVES: Apply conservation measures to the land. Determine the effects of these measures on the runoff water quality. Determine in so far as is possible the sources of the pollutants which are measured in Number 2. Learn what factors encourage or prevent land owners from applying conservation measures to the land. Evaluate the various methods for stabilization of stream channels.

APPROACH: Soil conservation measures will be designed and installed. Stream gauging and stream sampling sites will be established. The water analysis will be made in the laboratory. Insofar as possible pollutants identified will be traced to find their source. Subsurface drainage plans will be analyzed to determine their contribution. Land owners will be surveyed to determine their attitudes about the need for soil conservation. Various vegetative and mechanical approaches to stabilize stream channels will be installed and studied to determine their effectiveness.

KEYWORDS: WATER WATER-ANALYSIS SUBSURFACE-DRAINAGE STABILIZATION SOURCES CHANNELS-(WATERCOURSES) CHANNEL-STABILIZATION ENGINEERING RUNOFF STREAM-FLOW-RECORDS DRAINAGE-SYSTEMS CONSERVATION WATER-QUALITY EROSION SEDIMENTATION WATER-POLLUTION SOIL-CONSERVATION POLLUTANTS

PROGRESS:78/01 78/12
The second phase of the project which involves the application of Land Treatment Measures came to an end in October of 1977. Monitoring for water quality evaluation is continuing. Also, more detailed monitoring to evaluate the effect of individual practices has been initiated and equipment is being installed. The year 1978 was a very dry year and almost no water samples were obtained after the initial Spring storms. Of additional interest is the land owners' practices in keeping, installing additional, or plowing up some of the land treatment measures that were installed in Phase 2. All the contracts with the land owners for the installation of materials have expired, therefore the results of their activities may be very valuable in determining what may happen when 208 Plans start to be implemented. A review in the Fall of 1978 indicated that the original practices as installed are being maintained. There does not seem to be an additional land treatment being installed now that the promotional activities have ceased. There does appear however, to be a need for an educational program to encourage maintenance of the various measures.

PUBLICATIONS:78/01 78/12
MORRISON, J. (Editor), 1978, August, Environmental Impact of Land Use on Water Quality Project Data, EPA - 905/9-77-007C, 274 pages.

005A159
AGENCY: CSRS IND
PERIOD: 01 JUL 70 TO 30 SEP 80
INVEST: NELSON D W
PROJECT#: IND050054A
PERF ORG: AGRONOMY
LOCATION: PURDUE UNIV
LAFAYETTE IND

ENVIRONMENTAL ACCUMULATION OF NUTRIENTS AS AFFECTED BY SOIL AND CROP MANAGEMENT

OBJECTIVES: Evaluate the contribution of soil erosion and water runoff to nitrogen and phosphorus enrichment of water resources; seek management techniques to control nutrient enrichment of sediments; evaluate the availability of nitrogen and phosphorus associated with eroded soil materials to aquatic organisms.

APPROACH: A rainfall simulator will be used apply water at a specified rate and intensity to fertilized field plots. Samples of runoff water and sediment will be collected throughout each rainstorm and subsequently analyzed for nitrogen and phosphorus components. Factors to be evaluated in the study include soil type, soil slope, fertilizer rate and form, methods of fertilizer application, methods of soil tillage, rate of mulching, and intensity and duration of simulated rainstorm. Based on data obtained, management practices which reduce soil nutrient losses in surface runoff will be developed and tested. Laboratory incubation studies using algae as an indicator organism will be established to determine the availability of nutrients attached to soil particles entering natural waters through erosion.

KEYWORDS: WATER-QUALITY AQUATIC-LIFE ALGAE NUTRIENTS FERTILIZER-RATES MULCHING WATER MANAGEMENT SOIL-MANAGEMENT RAINFALL SEDIMENTS SOIL-EROSION RUNOFF NITROGEN WATER-RESOURCES SOIL-TYPES SLOPE TILLAGE FERTILIZERS NUTRIENT-LOSSES SOILS NITROGEN PHOSPHORUS APPLICATION-METHODS

PROGRESS:78/01 78/12
Monitoring studies in a 5000 ha watershed in Allen County, IN. continued. Soil and nutrient losses during 1978 were low because of limited rainfall and runoff. Laboratory studies of the avilability of P in the suspended sediments in streams of the Black Creek Watershed established that about 20% of the total sediment P and 30% of the sediment inorganic P would ultimately be available to algal cells. Phosphorus associated with amorphous iron and aluminum in sediments was the source of the majority of P assimilated by algal cells and a substantial proportion of the P (60%) present in this fraction was taken up by algal cells during a 2 week incubation. Rainfall simulator trials showed that (1) surface runoff losses of animal waste-derived nutrients (N and P) will be high if intense rainstorms occur soon after waste application, (2) incorporation of applied animal wastes will markedly reduce nutrient losses in runoff, (3) waste application tends to reduce soil loss because of a mulch effect, (4) sediment eroded from animal waste-treated areas is highly enriched with nutrients because of manure particles in transported solids, and (5) concentrations of soluble N and P compounds in runoff from waste treated areas are high enough to create water quality problems. /9-78-001. pp. 179-198.

PUBLICATIONS:78/01 78/12
DORICH, R.A. and NELSON, D.W. 1978. Algal availability of soluble and sediment phosphorous in drainage water of the Black Creek Watershed. In: Voluntary or Regulatory Approaches to Nonpoint Pollution Control. Proceedings of a USEPA

0057984
AGENCY: CSRS WIS
PERIOD: 01 JUL 70 TO 30 SEP 80
INVEST: KEENEY D R; HARRIS R F
PROJECT#: WIS01722
PERF ORG: SOIL SCIENCE
LOCATION: UNIV OF WISCONSIN
MADISON WIS

ENVIRONMENTAL ACCUMULATION OF NUTRIENTS AS AFFECTED BY SOIL AND CROP MANAGEMENT

OBJECTIVES: Evaluate the nonpoint sources of nutrients (primarily N and P) to waters and develop management systems that minimize nutrient losses and thereby reduce the environmental impact of man's activities and maximize efficiency of resource use. Specific objectives are: Evaluate agricultural production practices controlling mobility and transport of N and P in soil-plant-water systems. Develop management techniques to control nutrient enrichment of waters and maximize N and P fertilizer use efficiency.

APPROACH: Determination of the relative phosphate intensity-capacity and phosphate uptake characteristics of soils and algal cells will be stressed. Factors affecting availability of P in soil runoff will be evaluated as a function of the relative rate and extent of inorganic P release from soil particulates and uptake by algae. Management recommendations on the use of N-serve to increase N fertilizer efficiency and reduce N losses through denitrification and leaching will be evaluated in field trials and periodic sampling of the fertilizer band.

KEYWORDS: NUTRIENT-UPTAKE NUTRIENT-UPTAKE-(PLANTS) ALGAE SOILS MANAGEMENT FERTILIZERS WATER WATER-QUALITY WATER-POLLUTION NITROGEN RUNOFF NUTRIENT-LOSSES DENITRIFICATION LEACHING PHOSPHORUS EUTROPHICATION NITROGEN-TRANSFORMATIONS NUTRIENT-TRANSPORT

PROGRESS:77/01 77/12

Analyses of runoff from 20 rainfall-simulator plots in microwatersheds with different land uses showed highest total P, but lowest soluble P concentrations were associated with row crops and highest soluble P but lowest total P with alfalfa fields after frost in October. A routine method for estimating "algal-available" P was developed. In this method a 1:1000 suspension of the less than 20Mu size fraciton of a soil is shaken for 24 hrs with a 20-40 mesh cation exchange resin containing adsorbed polynuclear complexes of hydroxy-Al. After a sieve separation, the P adsorbed on the resin complex is determined. Resin extractable P was highly related (r equal to 0.98) with algal extractable P, with mean values of 162 Mug/g for resin, 169 Mug/g by algal extraction. Field studies with Nitrapyrin (NI) have shown good inhibition of nitrification on a silt loam and a sandy soil. However, in an experiment with fall and spring applied anhydrous NH(3), NI did not affect yield or N uptake by corn. Potato yields on an irrigated sand were consitently depressed by NI. This apparently was due to the excess of NH(4) to NO(3), which interfered with plant nutrition. Laboratory studies showed that sorption to organic matter is a major factor decreasing NI effectiveness. Chemical hydrolysis is the dominant hydrolysis mechanism and is not affected by pH or sorption to organic surgaces, but decreases with water content and increases with temperature.

PUBLICATIONS:77/01 77/12

HENDRICKSON, L.L., KEENEY, D.R. and WALSH, L.M. 1977. Improving nitrogen efficiency in irrigated sands with Nitrapyrin or sulfur-coated urea. Agron. Abstracts 1977, p. 159.

HENDRICKSON, L.L. 1977. Persistence and activity of Nitrapyrin and its effect on nitrification and plant growth. Ph.D. Thesis, Univ. Wisconsin-Madison. 217 p.

SAFFIGNA, P.G., KEENEY, D.R. and TANNER, C.B. 1977. Nitrogen, chloride and water balance with irrigated Russet Burbank potatoes in central Wisconsin. Agron. J. 69:251-257.

SAFFIGNA, P.G. and KEENEY, D.R. 1977. Nitrogen and chloride uptake by irrigated Russet Burbank potatoes. Agron. J. 69:258-264

SAFFIGNA, P.G., KEENEY, D.R. and TANNER, C.B. 1977. Lysimeter and field measurements of chloride and bromide leaching in an uncultivated loamy sand. Soil Sci. Soc. Am. J. 41:478-482.

0055253
AGENCY: CSRS NY.G
PERIOD: 01 OCT 77 TO 30 SEP 82
INVEST: PECK N H; VITTUM M T
PROJECT#: NYG33480
PERF ORG: SEED & VEGETABLE SCIENCES
LOCATION: N Y AGRICULTURE EXPT STATION
GENEVA NY

ORIGIN, TRANSFORMATION, AND MANAGEMENT OF NITROGEN IN SOILS, WATERS, AND PLANTS

OBJECTIVES: Develop management practices for minimizing enrichment of waters and optimizing nitrogen use in crop production.

APPROACH: Several aspects of vegetable production relating to optimal nitrogen fertilization and cultural practices will be investigated. Emphasis will be given to evaluating rate, time, and placement of urea, ammonium nitrate, diammonium phosphate, and slow-release nitrogen fertilizer as bases for achieving optimal nitrogen nutrition of certain vegetable crops. Use of cover crops and interplanted crops to minimize losses and maximize carry-over of nitrogen will be studied. The nitrogen contribution of legumes (snap beans, peas, and alfalfa) in rotation as revealed in nitrogen release and availability during the growing season will receive some attention. Evaluation of experiments will include nitrate tissue analysis to monitor the balance between rates of nitrate uptake and assimilation by plants at variour growth stages. Intensity and duration of solar radiation and other site variables will be measured as a basis for interpreting optimal nitrogen needs.

KEYWORDS: NITROGEN NITRATES FERTILIZATION PLANT-NUTRIENTS WATER-POLLUTION VEGETABLES SOILS WATER CULTURAL-PRACTICES FERTILIZER-APPLICATION UREA AMMONIUM-NITRATE AMMONIUM-PHOSPHATE SLOW-RELEASE-FERTILIZERS COVER-CROPS INTER-PLANTING NUTRIENT-LOSSES NUTRIENT-UPTAKE-(PLANTS) PLANT-NUTRITION LEGUMES CROP-ROTATION

PROGRESS:77/01 77/12
Seedling responses to sources of N fertilizers were determined for sweet corn variety Jubilee. Ammonium nitrate (AN), urea (U), ammonium sulfate (AS), and calcium nitrate (CN) were applied in a band zone 5 cm to the side and 5 cm below the seeds at planting time, at rates of 0 to 20 g N per m of row. Constant rates of 5 g P from CSP plus 5 g K from KCl per m of row were also applied in the band. The soil was a fine sandy loam derived from calcareous glacial till. AS caused the lowest concentration of nitrate in the plants. AN and AS produced seedlings with greater dry weight than U or CN. Plants grown with CN had high concentration of Ca and low concentration of P. Rates of about 4 g N per m row produced the greatest dry weight per plant and the highest concentration of P in the plants. Equipment was constructed in a greenhouse to expose plants to gradually increasing or decreasing light coming from different angles or directions, thus simulating natural outdoor conditions, in order to study the diurnal variation of nitrate in plants. Responses of vegetables to nitrogen will be determined by measuring plant growth and uptake of nitrate-N and total N during growth, development, and maturation.

PUBLICATIONS:77/01 77/12
NO PUBLICATIONS REPORTED THIS PERIOD.

0045395
AGENCY: ARS 3505
PERIOD: 25 JUN 79 TO 25 JUN 83
INVEST: LINDSTROM M J; HOLT R F
PROJECT#: 3505-20750-008
PERF ORG: USDA-ARS TILLAGE WATER USE &
SOIL-PLANT-ATMOS RES
LOCATION: NC SOIL CONSERVATION RES LAB
MORRIS MIN

ASSESSMENT OF THE EFFECT OF RESIDUE HARVESTING ON THE SOIL SYSTEM

OBJECTIVES: To determine the effect of residue removal for energy production on water runoff, soil erosion, nutrient transport, and soil physical and chemical changes.

APPROACH: Triplicate runoff plots equipped to measure runoff, sediment, and nutrient transport will be established at Madison, South Dakota and Morris, Minnesota. Residue removal will be based on the calculated (USLE) amounts of residue needed (Y) to maintain soil loss levels at the soil loss tolerance (T) level for a conservation tillage system. Residue levels will be Y, 2Y, and 1/2Y. Tillage systems will include a conventional fall plow, spring disk, and harrow, a conservation, and a no till system. Base soil physical and chemical properties will be measured at the initiation of the experiment and monitored for changes with time for the various residue and tillage systems.

KEYWORDS: #REVIEW-PENDING-79228

0044804
AGENCY: ARS 3302
PERIOD: 02 OCT 78 TO 02 OCT 81
INVEST: BRADFORD J M
PROJECT#: 3302-20800-004
PERF ORG: USDA-ARS-WATER EROSION RES
AGRONOMY DEPT
LOCATION: PURDUE UNIV
LAFAYETTE IND

SOIL CHARACTERIZATION FOR ERODIBILITY

OBJECTIVES: Develop laboratory test procedures to measure the soil's ability to resist soil detachment. Determine soil and water properties responsible for differences in detachment processes. Define tillage or management methods which reduce soil erodibility and surface runoff and improve seedling environment. Relate erosion processes to soil horizon strength differences within a particular soil profile and for different stratigraphic and geomorphic settings. Separate rill and interill erodibility factors on the basis of soil properties.

APPROACH: Laboratory shear strength determinations and raindrop impact studies will be used to study soil detachment. Field studies will include a characterization of hydaulic properties in relation to soil detachment. Stress-deformation properties of soils under various loading conditions will be determined for particular soil horizons within a particular soil profile and for soils under different stratigraphic and geomorphic settings. These properties will be related to erosion processes. Management or tillage systems will be tested to reduce soil erosion and surface water-runoff.

KEYWORDS: EROSION SOILS SOIL-EROSION LABORATORY-TECHNIQUES TESTING MEASUREMENT SOIL-PROPERTIES DETACHMENT-MECHANISMS TILLAGE EROSION-CONTROL RUNOFF SOIL-HORIZONS SOIL-PROFILES IMPACT RAIN RAINDROP-EROSION SURFACE-WATER SOIL-BULK-DENSITY SOIL-STRUCTURE RILL-EROSION SOIL-CHARACTERISTICS CHARACTERIZATION

0044803
AGENCY: ARS 3302
PERIOD: 02 OCT 78 TO 02 OCT 81
INVEST: MOLDENHAUER W C
PROJECT#: 3302-20800-003
PERF ORG: USDA-ARS-WATER EROSION RES
AGRONOMY DEPT
LOCATION: PURDUE UNIV
LAFAYETTE IND

TILLAGE-MULCH EFFECTS ON EROSION AND INFILTRATION

OBJECTIVES: Determine the tillage-mulch interaction on soil erosion and infiltration. Determine the effect of compaction on infiltration and hydraulic conductivity. Develop a tillage component for an agricultural chemical transport model. Develop soil conditioners and stabilizers for control of erosion on critical areas. Determine size distribution of eroding material and the influence of this distribution on transport of agricultural chemicals. Develop practical farming systems for conservation.

APPROACH: Field studies will include use of a rainulator for measuring soil and water losses and a sprinkling infiltrometer for determining field hydraulic conductivity and infiltration. Usual laboratory determinations of soil density and clod size distribution will be made, and new methods for characterizing the tilled zone will be developed. A laboratory rain simulator will be used to determine the effectiveness of soil stabilizers and conditioners. Samples will be taken during rainulator runs to determine size distribution of eroded materials, and for chemical and physical analyses. Erosion control effectiveness of farming systems will be determined using on-going experiments at Purdue University and Wooster, OH.

KEYWORDS: TILLAGE MULCHES SOILS EROSION SOIL-EROSION INFILTRATION COMPACTION SOIL-COMPACTION MODELS TRANSPORT SOIL-CONDITIONERS SOIL-STABILIZATION RAIN-SIMULATION MEASUREMENT HYDRAULIC-CONDUCTIVITY SOIL-DENSITY PARTICLE-SIZE CHEMICAL-PROPERTIES PHYSICAL-PROPERTIES EROSION-CONTROL RUNOFF SOIL-CHARACTERISTICS SOIL-LOSS WATER-LOSS

0043789
AGENCY: ARS 3505
PERIOD: 23 MAY 77 TO 23 MAY 80
INVEST: ONSTAD C A; HOLT R F; YOUNG R A
PROJECT#: 3505-20800-004
PERF ORG: USDA-ARS POLLUTION &EROSION RE
S
LOCATION: NC SOIL CONSERVATION RES LAB
MORRIS MIN

ASSESSMENT OF SEDIMENT ATTRIBUTED TO UPLAND EROSION IN MINNESOTA AGRICULTURAL AREAS

OBJECTIVES: Develop, test, and refine mathematical modeling techniques for estimating erosion and sediment yields from ungaged agricultural watersheds for time periods ranging from a single storm to annual amounts. Soil, physical, hydrological and meteorological characteristics and cultural practices will also be related to sediment source areas for given basins.

APPROACH: This study will rely heavily on the use of readily available data for the model watershed parameters. These data include the Conservation Needs Inventory data county land use data, geomorphic soil landscape descriptions, regional soil associations, and USGS topographic maps. Other model inputs include the traditional USLE parameters. Existing data obtained from state and federal agencies will be used to calibrate the models so that they can be used on ungaged watersheds. When satisfactory validation is reached on large basins, smaller areas will be investigated with the intent of isolating and characterizing sediment sources for county or sub-county sized areas.

KEYWORDS: STREAMS GULLIES SEDIMENT-SOURCES SOILS SEDIMENTATION MATHEMATICAL-MODELS DATA-COLLECTION HYDROLOGY CALIBRATION RILL-EROSION MODELS WATERSHEDS SEDIMENTS EROSION PRECIPITATION SEDIMENT-TRANSPORT RUNOFF

PROGRESS:77/04 77/12
Average annual sediment yields have been determined for broad areas in Minnesota. These determinations were made using established techniques with available land use, soils, streamflow, and sedimentation data. The highest sediment yield of of over 1050 kg/ha occurs in the Root River in extreme southeast Minnesota. In general, the driftless area of southeastern Minnesota had the highest intensive agricultural areas of southern and western Minnesota range from 56 kg/ha in the lower rainfall areas of West Central Minnesota to 560 kg/ha in South Central Minnesota. Thoughout the state, the largest amount of sediment is lost in the months of March through June. This amounts to about 75 percent of the total yield. Nearly 30 percent of the average annual sediment loss occurs in the month of April alone. The sediment yield peak does not coincide with that of rainfall but more closely coincides with streamflow. The time of highest sediment yield coincides with the occurrence of spring tillage operations, however, channel cleanout from streambank or gully erosion also occurs during high flow periods. Detailed investigation of the sediment sources are continuing.

PUBLICATIONS:77/04 77/12
NO PUBLICATIONS REPORTED THIS PERIOD.

0043788
AGENCY: ARS 3505
PERIOD: 01 JUN 77 TO 01 JUN 80
INVEST: YOUNG R A; VOORHEES W B
PROJECT#: 3505-20800-003
PERF ORG: USDA-ARS TILLAGE WATER USE &
SOIL-PLANT-ATMOS RES
LOCATION: NC SOIL CONSERVATION RES LAB
MORRIS MIN

EFFECTS OF AGRICULTURAL WHEEL TRAFFIC ON SOIL EROSION AND RUNOFF

CBJECTIVES: Study the effect of controlled wheel traffic and subsequent soil compaction on infiltration, runoff, surface sealing, and soil erosion.

APPROACH: A rainulator will be used to apply known amounts of rainfall energy on plots in which a history of wheel traffic has been established. Standard runoff collection procedures will be modified to separate wheel track erosion and runoff from that occurring in the non-tracked areas. Various field and laboratory measurements will be made to determine basic cause and effect relationships between wheel traffic soil compaction, and erosion. This includes the density and stability of soil clods, surface roughness and porosity, clod size distribution etc.

KEYWORDS: SOIL-POROSITY CLODS SOILS TRAFFIC WHEELS SOIL-SURFACE SOIL-ERODIBILITY SOIL-CHARACTERISTICS SOIL-EROSION INFILTRATION SOIL-COMPACTION RUNOFF EROSION

PROGRESS:77/08 77/12
Sixteen plots were established and planted to soybeans. Particle size distributions and aggregate size distributions were determined and random roughness was measured for the soil areas within the wheel tracks and between the wheel tracks. Runoff and soil loss from these areas will be studied under simulated rainfall in 1978.

PUBLICATIONS:77/08 77/12
NO PUBLICATIONS REPORTED THIS PERIOD.

0032529
AGENCY: CSRS OHO
PERIOD: 01 OCT 68 TO 31 DEC 80
INVEST: SCHWAB G O; FAUSEY N R; TAYLOR
PROJECT#: OHO00064
PERF ORG: AGRI ENGINEERING
LOCATION: OHIO AGRICULTURAL R AND D CENTER
COLUMBUS OHO

DRAINAGE SYSTEMS DESIGN FOR POLLUTION CONTROL AND CROP PRODUCTION

OBJECTIVES: Determine the effectiveness of various systems on crop production under field conditions. Determine tile outflow, surface runoff, and the quantity and kinds of soluble and suspended materials in drainage water resulting from pesticide, and fertilizer applications. Compare crop yields with and without irrigation in order to adjust prior yield data for excess water.

APPROACH: Proposed crop, and water management practices to end of project are a rotation of corn, oats and soybeans in split plot design, using no irrigation on one group and 6 inches of water applied in two applications on the others. Rainfall, surface runoff, tile flow, solar radiation, and temperature of soil and air will be recorded as has been done for several years. Drainage water and sediment in the water will be analyzed for plant nutrients (NO(3)., PO(4)., K., Ca.., Mg.., Na., Cl.). Sediment content, pH and electrical conductivity will also be measured. A high, uniform fertilization rate will be maintained on all plots. Crop response will be measured by stand counts and crop yields. Lysimeters of undisturbed soil from 4 soil types - Toledo, Hoytville, Brookston and Genesee, will be used also.

KEYWORDS: DRAINAGE DRAINAGE-SYSTEMS CROP-PRODUCTION CROP-YIELDS TILE-DRAINAGE WATER-QUALITY SEDIMENTS WATER-POLLUTION RUNOFF PESTICIDES FERTILIZERS IRRIGATION CORN OATS SOYBEANS CROP-RESPONSE SOILS ENGINEERING NUTRIENTS

PROGRESS:78/01 78/12
The tile drainage field experiment was in corn, soybeans, and oats (split plot). Average corn yields in 1978 were 7589 kgs/ha for surface drainage only, 8781 kgs/ha for tile drainage only, and 9283 kgs/ha for combination of tile and surface drainage. These are more than 30% higher than the 10-year average, partly due to higher nitrogen fertilization. Soybean yields were 2688, 3226, and 3360 kgs/ha, respectively. They were nearly the same as the 3-year average. Oat yields were 2688, 3405, and 3620 kgs/ha, respectively. These were all more than 85% higher than the 4-year average. Average annual sediment losses for the 9-year period (1969-1977) were 2678 and 1676 kgs/ha for surface runoff and tile flow, respectively. Corresponding losses for NO(3)-N for the same period were 16 and 25 kgs/ha; for P, 2.2 and 1.2 kgs/ha; and for K, 32 and 24 kgs/ha. Lysimeter plots were in corn in 1978 with yields varying from 8655 to 11,164 kgs/ha among the four soil types. Yields were nearly the same for the two water table levels.

PUBLICATIONS:78/01 78/12
SCHWAB, G.O. 1978. Effect of openings on drain inflow. Drainage Contractor 4(12):40. June.
SCHWAB, G.O. 1978. Age effects on sub-surface drain flow. Drainage Contractor 4(12):24. June.
SCHWAB, G.O. 1978. Environmental water management research and practices in Ohio. Fulbright-Hays lecture given at University of Ljubljana, Yugoslovia. May.

0027533
AGENCY: CSRS ILLU
PERIOD: 01 MAY 78 TO 30 SEP 82
INVEST: LEMBKE W D; MITCHELL J K; WALKER P N
PROJECT#: ILLU-10-0319
PERF ORG: AGRI ENGINEERING
LOCATION: UNIV OF ILLINOIS
URBANA ILL

SOIL AND WATER CONTROL SYSTEMS APPLIED TO ILLINOIS

OBJECTIVES: Study soil and water control systems for Illinois in order to optimize crop production while preserving soil and water resources.

APPROACH: Develop and use mathematical, electrical, hydraulic and hydrologic models of evaluate the performance of soil and water control systems in Illinois. Evaluate the benefits of irrigation and drainage systems on Illinois soils. Surface depression storage will be quantified as a function of soil permeability, rainfall intensity-duration and runoff. Erosion and deposition of soil aggregates and soil particles will be studied in the laboratory and in the field to define management conditions causing excessive erosion and depostion. Crusting of soil will be studied as a factor determined by the soil aggregate stability and rainfall energy.

KEYWORDS: SOIL WATER CONTROL MODELS HYDROLOGY HYDROLOGIC-MODELS IRRIGATION-SYSTEMS DRAINAGE-SYSTEMS SOIL-PERMEABILITY EROSION SOIL-PARTICLES DRAINAGE IRRIGATION CONTROL-SYSTEMS ENGINEERING RESOURCE-CONSERVATION RAINFALL RUNOFF WATER-STORAGE

PROGRESS:77/01 77/12
A cooperative project between the Department of Agricultural Engineering and the Department of Agronomy has been initiated to study irrigation and drainage on claypan soils. Irrigation treatments are sprinkler, furrow and no irrigation. Drainage treatments are surface, subsurface, surface plus subsurface and no drainage. During 1977 irrigated plot yields averaged 9.3 tonnes/ha. while nonirrigated plot yields averaged 4.3 tonnes/ha. A study was also initiated to determine at what vertical deflection failure of corrugated plastic drain tubing occurs. This study includes the determination of hydraulic capacity, tubing stiffness and load carrying capacity as functions of tubing deflection. A study of soil crusting involved the emergence of soybean plants through a crust formed by the application of simulated rainfall. Soil texture, organic matter, rainfall intensity and rainfall energy are the independent variables being controlled in this study.

PUBLICATIONS:77/01 77/12

DRABLOS, C.J.W., WALKER, P.N. and SCARBOROUGH, J.N. 1977. Field Evaluation of Corrugated Plastic Drain Tubing. Proceedings of Third National Drainage Symposium. American Society of Agricultural Engineers. ASAE, St. Joseph,

WALKER, P.N. and LEMBKE, W.D. 1977. Recycling Agricultural Runoff. University of Illinois Water Resources Center Research Report No. 119. 88 pages.

ELLIOTT, R.L., LEMBKE, W.D. and HUNT, D.R. 1977. A Simulation Model for Predicting Available Days for Soil Tillage. Transactions of ASAE 20(1):4-8.

VOORHEES, M.L. and WALKER, P.N. 1977. Tractionability as a Function of Soil Moisture. Transactions of ASAE 20(5):806-809.

0001860
AGENCY: CSRS ILLU
PERIOD: 13 JUL 55 TO 30 SEP 79
INVEST: MITCHELL J K; DICKEY, E C
PROJECT#: ILLU-10-0312
PERF ORG: AGRI ENGINEERING
LOCATION: UNIV OF ILLINOIS
URBANA ILL

RUNOFF FROM SMALL AGRICULTURAL AREAS IN ILLINOIS

OBJECTIVES: Determine the frequencies of peak rates and volumes of runoff from agricultural watersheds of 25 to 1000 acres located on permeable soils with mild slopes in Central Illinois. Test and evaluate the usefulness of mathematical hydrologic models to small agricultural watersheds with mild topography. Provide benchmark watersheds in Central Illinois for the study of the quality of runoff water.

APPROACH: Four fully instrumented watersheds are being maintained near Monticello, Illinois. To supplement data obtained at Monticello, maximum stage recorders are installed on watersheds ranging in size from 45 to 1400 acres. Model studies and field calibrations have been conducted on several field structures.

KEYWORDS: MANAGEMENT-SYSTEMS SOIL-PERMEABILITY MATHEMATICAL-MODELS FREQUENCY SOIL-WATER-RELATIONS RATE-DETERMINATION VOLUME WATER-FLOW WATER-QUALITY HYDROLOGY CROPPING-SYSTEMS WATERSHEDS RUNOFF ENGINEERING SLOPES

PROGRESS:77/01 77/12
The 1975 and 1976 rainfall and runoff data from the Allerton watersheds have been reduced, tabulated, and assembled for analysis. The temperature-humidity data is transcribed through 1970. The total rainfall for 1975 was 1080 mm which was 130 mm greater than normal. The rainfall for 1976 was 820 mm, a lower than normal rainfall total. Runoff events were quite numerous in 1975 with 59 mm of runoff recorded from Watershed B1. However, only 12 mm of runoff was recorded from Watershed A1. Although total rainfall was less than normal in 1976, runoff from Watershed A1 and B1 was 32 and 26 mm respectively. The rainfall deficiencies occurred in January, April, November and December. Rainfalls occurring the last of February and in March produced 95 percent of the runoff. A study was completed that provides rainfall intensity-and runoff depth-duration frequency data for the rainfall and runoff events at the Allerton Watersheds. Statistical analysis were conducted on rainfall and runoff data through 1975. These analysis indicated that the length of record for annual rainfall, annual maximum intensity, annual exceedance runoff and other weather data is adequate. The length of record is not adequate for monthly rainfall analyses and annual exceedance runoff analysis for Watershed W1. A study is in progress using the rainfall-runoff records from Watersheds A1 and B1 as a basis for comparing watershed models for agricultural areas of mild topography.

PUBLICATIONS:77/01 77/12
HARDJOAMIDJOJO, S. 1977. Hydrologic frequency study and analyses for Allerton agricultural watersheds. Unpublished M.S. Thesis, Library, University of Illinois at Urbana-Champaign.

0001407
AGENCY: CSRS IND
PERIOD: 01 JUL 68 TO 30 SEP 83
INVEST: MONKE E J
PROJECT#: IND04G020
PERF ORG: AGRI ENGINEERING
LOCATION: PURDUE UNIV
LAFAYETTE IND

IMPROVING THE QUALITY OF LLAND AND WATER RESOURCES

OBJECTIVES: To study the effect of drainage practices on cropping management, crop response, and water, sediment and nutrient yields, to investigate factors affecting soil erosion and crusting, to measure and predict sediment and related-chemical pollution of streams and lakes from rural sources, and to study the dynamics of water and pollutant movement in soil.

APPROACH: The general approach is to simulate the movement and reactions of water and waterborne pollutants through the soil and overland into streams or lakes. The models will be used to establish field experiments to validate the models or to suggest model changes. In addition, seperate laboratory experiments will be conducted to study specific factors concerning soil erosion and crusting.

KEYWORDS: #REVIEW-PENDING-79211

PROGRESS:78/01 78/12
Collection and analysis of runoff, sediment yield and nutrient loss data from a 4900 ha agricultural watershed have been continued. A computer model was developed to identify source areas of the sediment and related chemical pollutants based on the output data, soils and topographic information, and land use. Several smaller, single practice watersheds have now been instrumented within the larger watershed to verify the model results and to provide baseline information for effects of land use in runoff water quality. Battery-powered sampling instrumentation was also developed and tested. Discharge of sediment from tile outfalls draining heavy lakebed soils in the Maumee Basin has been previously noted. Subsequently discharge from a 17 ha subsurface drainage system in Hoytville silty clay was monitored. After an initial flush which did not always occur, sediment concentrations tended to remain uniform irrespective of discharge rates. A computer model was calibrated and verified using this discharge data. A comparison laboratory experiment employing intermittent wetting and drying of soil columns showed that Hoytville silty clay (a lakebed-associated soil, 44% clay) and Latty silty clay (a lakebed soil, 48% clay) discharged approximately 6 and 8 times, respectively, the weight of sediment as discharged from a column of Blount soil loam (a glacial till soil, 30% clay).

PUBLICATIONS:78/01 78/12

MONKE, E.J. and WHEATON, R.Z. 1978. Sediment contributions to the Maumee River.

What level of sediment control is feasible? EPA-905/9-78-001. Proc. of Conference on Voluntary and Regulatory Approaches for Nonpoint Source Pollution MONKE, E.J. and BOTTCHER, A.B. 1978. Tile drainage studies. In: Environmental Impact of Land Use on Water Quality - Final Report on the Black Creek Project.

J. Lake (dir.) and J. Morrison (ed). EPA-905/9-77-007-B, USEPA, Region V, BOTTCHER, A.B. 1978. Simualtion of a tile drainage system with associated sediment transport. Ph.D. Thesis. Purdue University, W. Lafayette, IN 137p.

/9-77-007-B, USEPA, Region V. Chicago, IL. pp. 252-272.

MONKE, E.J., NELSON, D.W., BOTTCHER, A.B. and SOMMERS, L.E. 1978. Sources of sediment and related pollutants - Comparison of subwatersheds. In: Environmental Impact of Land Use on Water Quality - Final Report on the black

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0057925
AGENCY: CSRS MICL
PERIOD: 01 JUL 70 TO 30 SEP 80
INVEST: ZINDEL H C
PROJECT#: MICL01064
PERF ORG: POULTRY SCIENCE
LOCATION: MICHIGAN STATE UNIV
EAST LANSING MIC

ANIMAL WASTE MANAGEMENT SYSTEMS FOR THE 1980'S

OBJECTIVES: Develop optimal animal manure management systems to meet evolving environmental and economic requirements and be compatible with increasing needs for animal protein. Characterize atmospheric contaminants and develop abatement methods to eliminate contaminants potentially harmful effects on human and animal health. Investigate use of by products of animal manure management systems for energy sources, feed ingredients, plant nutrients for crop production and other potential uses. Characterize non-point population water runoff sources from livestock and poultry enterprises on pasture production systems and land areas with manure application and further develop guidelines for abatement of non-point pollution sources from animal manures.

APPROACH: Waste management systems presently employed in Michigan will be monitored and evaluated for improved design for machinery management technique and collection alleyways. Determine the influence of feeding an odor suppressant to broilers and laying hens in relationship to feed efficiency, weight gain, and fecal odors. Study of anaerobic organisms in poultry anaphage. Upgrading the crude protein of anaphage. Study the calcium and postasium availability from poultry anaphage. Study the amino acid availability by employing turn-over rate estimates, involving radio labeled amino acids.

KEYWORDS: MANURE-MANAGEMENT POLLUTION #EWU POULTRY ANIMAL-WASTE ODOR WASTE-UTILIZATION ANIMAL-NUTRITION POULTRY-MANURE CALCIUM RUNOFF PASTURES ENERGY-SOURCES POTASSIUM PROTEIN-SOURCES WASTE-MANAGEMENT FEED GUIDELINES PLANT-NUTRITION AMINO-ACIDS FEED-EFFICIENCY WEIGHT-GAINS WATER-POLLUTION BYPRODUCTS #ERP

PROGRESS:78/01 78/12
A flat-plate 110m 2 solar collector was used for supplemental heating of ventilation air entering a poultry layer house. This supplemental heat made it possible to maintain higher in-house temperatures in Michigan without temperature stratification. Further work is underway to establish the humidity gradient across the house.

PUBLICATIONS:78/01 78/12
HALL, F.W., ESMAY, M.L., FLEGAL, C.J., SHEPPARD, C.C. and ZINDEL, H.C. 1978.
Solar heating: impact on poultry layer house. Paper number 78-4558, 1978. Annual Meeting, American Society of Agricultural Engineers.
RICHMOND, D. and CHANG, T.S. 1978. A comparison of drop-plate and pour-plate methods for bacterial population counts of poultry anaphage (dehydrated caged layer excreta). Poultry Science 57:293-295.

0070237
AGENCY: CSRS ILLU
TO 30 SEP 79
INVEST: WALTERS C S; GILMORE A R
PROJECT#: ILLU-55-0336
PERF ORG: FORESTRY
LOCATION: UNIV OF ILLINOIS
URBANA ILL

POLLUTION OF SOIL AND GROUNDWATER BY WOOD PRESERVATIVES AS A FUNCTION OF RAINFALL

OBJECTIVES: Determine the amount of arsenic leached from wood treated with four commercially-important, water-soluble preservatives. Determine the extent of pollution of soil, surface runoff, and soil filtrate by woods treated with chromated copper preservatives containing arsenic or a fluor-chrome-arsenate-phenol formulation.

APPROACH: Pressure treated pine post stubs with a known amount of preservative will be exposed in a teflon box. The box will permit the collection of surface runoff, filtrate and soil for quantitative analyses. Three soil types will be exposed to "rain" from a raintower facility to facilitate leaching of arsenic from the wood.

KEYWORDS: SOIL-WATER GROUNDWATER WOOD-TREATMENT RUNOFF RAIN RAINFALL PRECIPITATION SOILS SOIL-POLLUTION PRESERVATIVES ARSENIC LEACHING POLLUTION

PROGRESS:77/01 77/12
Soil pans were constructed so that Douglas fir plywood specimens treated with copperized chrome arsenate wood preservatives could be exposed in a raintower. Samples of surface runoff and leachate were collected at intervals ranging from 15 minutes to 27 hours. About 600 samples of soil, wood, cheesecloth (filter), leachate, and surface runoff were collected for arsenic analysis. The arsenic determinations will be completed by February 1978.

PUBLICATIONS:77/01 77/12
NO PUBLICATIONS REPORTED THIS PERIOD.